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Federal Noise Research in Noise Effects

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ABSTRACT

The Federal Noise Effects Research Program was documented and reviewed. The program expanded slightly over the last few years, with more agencies participating. The program is reasonably comprehensive and in general coordinated with no unjustified overlap of efforts.

Research needs to support and justify regulatory and standards requirements were identified by the Panel as being of the highest priority. Satisfaction of these relatively short term goals with present budget restrictions could jeopardize long-range basic research needs to understand basic effects mechanisms. To satisfy both requirements, the Panel on the average recommends an increase of the overall Federal noise effects research budget of 40%.

The Panel recommends several specific research topics for high priority funding. Some of these recommendations are the same ones listed among the 1974 recommendations, and the Panel was concerned about the only partial responsiveness to previous findings.

Among the areas requiring additional support are effects of noise on sleep, and community or collective response. The area primarily requiring additional support priority and clarification is the area of non-auditory health effects, since no major well planned program for this area was apparent.

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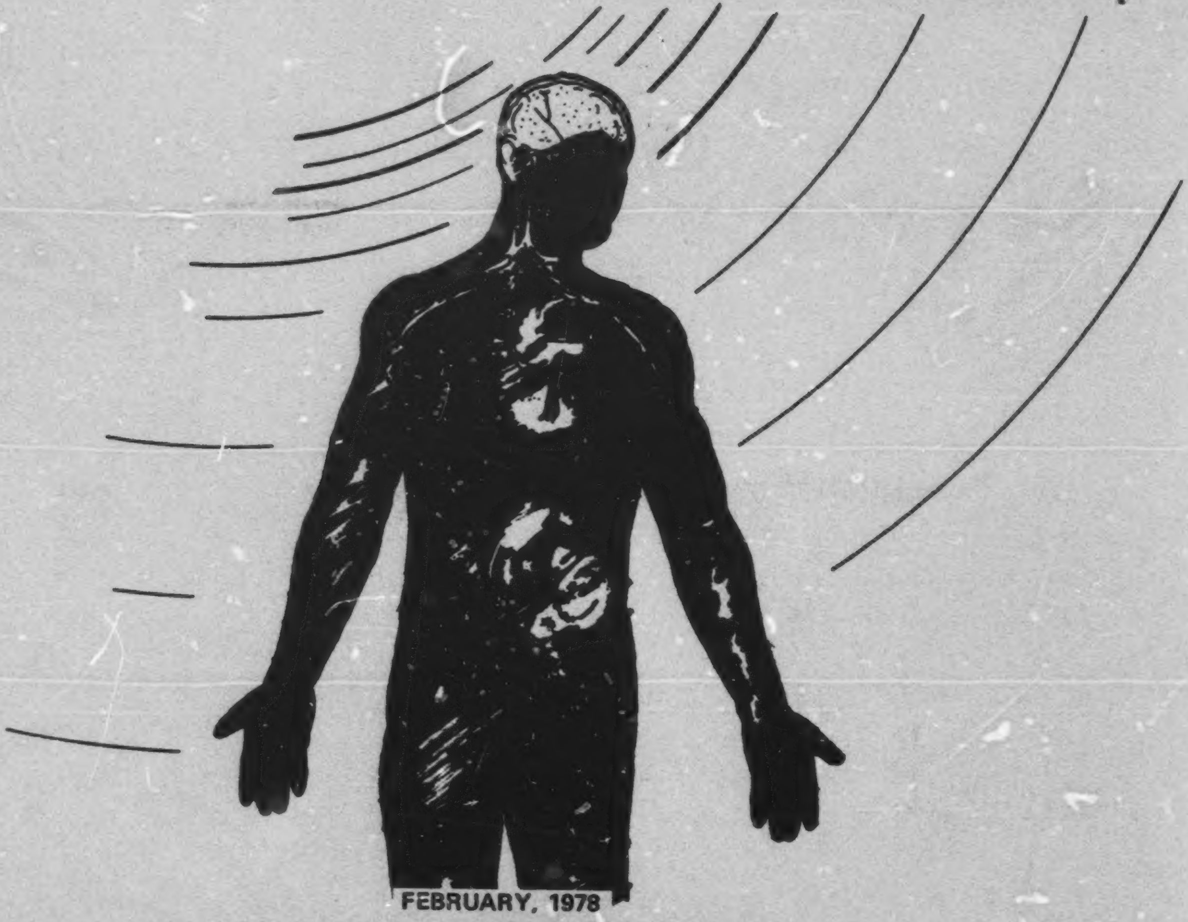
FEDERAL NOISE RESEARCH

IN
NOISE EFFECTS



FEBRUARY, 1978

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF NOISE ABATEMENT AND CONTROL
WASHINGTON, D.C. 20460

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REPORT OF THE SECOND FEDERAL INTERAGENCY NOISE EFFECTS RESEARCH PANEL

Panel No. 4 of the Four Interagency Panels
Established by the U.S. EPA to Review
Federally-Sponsored Noise Research

MAIN FINDINGS AND RECOMMENDATIONS

1. The Federal Noise Effects Research Program was documented and reviewed. The program expanded slightly over the last few years, with more agencies participating. The program is reasonably comprehensive and in general coordinated with no unjustified overlap of efforts.
2. Research needs to support and justify regulatory and standards requirements were identified by the Panel as being of the highest priority. Satisfaction of these relatively short term goals with present budget restrictions could jeopardize long-range basic research needs to understand basic effects mechanisms. To satisfy both requirements, the Panel on the average recommends an increase in the overall Federal noise effects research budget of 40%.
3. The Panel recommends several specific research topics for high priority funding. Some of these recommendations are the same ones listed among the 1974 recommendations, and the Panel was concerned about the lack of responsiveness to previous findings.
4. Among the areas requiring additional support are effects of noise on sleep, and community or collective response.
5. The area primarily requiring additional support priority and clarification is the area of non-auditory health effects, since no major well planned program for this area was apparent.

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CHAPTER I

INTRODUCTION

The Noise Control Act of 1972 gives the Environmental Protection Agency the responsibility for coordinating the noise control research programs of all Federal agencies. The Act also states that EPA shall report to Congress from time to time on the status and progress of the Federal program.

To assist in this effort EPA established four interagency panels to review federal noise research in the following areas:

- Noise effects
- Surface transportation noise
- Machinery/Construction noise
- Aircraft noise

These Panels met for the first time in late 1973 and early 1974. Their results were presented as EPA's "First Report on the Status and Progress of Noise Research and Control Programs FY 73-75." In late 1976 the Panels were reconvened to report on current research.

The present report is the second report of the Federal Interagency Noise Effects Research Panel, covering the fiscal years 1975, 1976, and 1977.* Panel members include representatives from the Department of Commerce, the Consumer Product Safety Commission, the Department of Defense, the Environmental Protection Agency, the Department of Health, Education and Welfare, the Department of Interior, the Department of Labor, the National Aeronautics and Space Administration, the National Science Foundation, the Department of Transportation, and the Veterans Administration. Every major Federal agency was invited to send a representative. Because of the relatively small size of their noise programs the Department of Agriculture and the Energy Research and Development Administration provided information but only limited participation. The Department of Housing and Urban Development was not able to provide an active participant. Dr. Henning Von Gierke, Director of the Biodynamics and Bionics Division of the Air Force Aerospace Medical Research Laboratory at Wright-Patterson AFB, served as chairman of the Panel, and Ms. Alice Suter of EPA's Office of Noise Abatement and Control acted as Executive Secretary. See Appendix A for the names and affiliations of the Panel members.

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* In some cases agencies reported funding through FY 78 since these funds represent a continuation of the project as noted. Although FY 78 funds are shown to indicate the continuation of a project, they are not used in the analysis of this report.

This report addresses Federally sponsored research concerned with the effects of noise on the public health and welfare. However, inquiries were made about the availability of similar research under other sponsorship. Appendix C describes research funded by State, municipal and private institutions. A separate report discusses research conducted in foreign countries*. Although considerable information has been made available to the Panel, particularly on foreign research, it is not nearly as complete as that supplied by the Federal agencies. Although many foreign projects were identified, the amount of information on each project presently is insufficient to assess their potential contribution toward filling Federal research needs. Hopefully more useful information will be collected on foreign research.

The research that is being performed by the various Federal agencies is diverse in nature and reflects each agency's different mandate. When viewed in the aggregate these studies provide needed information for assessing and establishing a coordinated Federal research program whose objective is to develop criteria, standards and guidelines to protect the public health and welfare against the adverse effects of noise. General areas of funding, emphasis, gaps and priorities will be discussed in the body of the document. Summaries of the individual projects arranged according to the sponsoring agency are located in Appendix C.

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* EPA Report No. 550-9-78-101, Foreign Noise Research in Noise Effects, January 1978.

Panel's Goals and Methods

The Panel's function is to report on current Federal research, and then make recommendations to Congress and the Office of Management and Budget for the most effective use of Federal resources. Towards this end the following objectives were set:

- Review and assess the current state of noise effects research.
- Identify research gaps, areas of overlap, and areas where more emphasis is needed.
- Prioritize identified areas of need.
- Discuss the relationship of Federally funded programs to those of the private sector and of the international community.
- Discuss current research problems as they arise, and develop recommendations for their solution.

For the purposes of this report noise effects research projects have been classified into nine broad subject areas listed below:

I. Noise-Induced Hearing Loss
II. Non-Auditory Health Effects
III. Psychological and Performance Effects
IV. Noise Effects on Sleep
V. Communication Interference
VI. Community or Collective Response
VII. Domestic Animals and Wildlife

VIII. Noise Environment Determination

IX. Human Response to Noise Concomitant with Vibration.

Description of the categories is given in Chapter II. Research on effects of noise on buildings and other non-living things is outside the scope of the Panel. This categorization scheme has been kept essentially the same as the one developed by the first Panel. In this way, past and present research emphases for each category could be compared to determine the progress of noise effects research since 1974, and to see the extent to which the recommendations of the last Panel has been addressed.

The recommendations presented in this report represent a general consensus of the Panel members. Although there is wide agreement that certain areas need increased attention, opinions on other areas are quite mixed and reflect the diversity of interests and missions of the various Federal agencies. These recommendations primarily address areas that need further research and the prioritization that should take place within a coordinated Federal program. Underlying the Panel's agreement is the feeling that noise effects research is needed by all the agencies--that work of the agencies, including regulations and Environmental Impact Statements, should be based on the same criteria, if not always the same chosen level limits. No attempt has been made to assess the contribution of specific projects since time and organizational constraints would have prohibited an attempt at consensus on every project, but an assessment of the value of various research topics has been made through the process of prioritization.

Information on the various agencies' noise effects research projects has been provided by Panel members. In addition, a literature search was done by the Smithsonian Scientific Information Exchange, whose data base includes reports on Federal research in progress.

Preliminary data for FY 78--Between the last Panel meeting and the final draft of the Panel Report, additional information on FY 78 funding was acquired. This information may be found on pp. IV-2 and IV-3. Some agencies were able to provide complete data and others only gross budget estimates, since not all projects under consideration had yet been initiated. Thus the following overall funding data may be subject to revision. However, it is felt the information is now substantially accurate. Moreover, the picture for FY 78 seems to be a continuation of the trends of the previous years. There are few abrupt changes in funding, either by agency or by category, with the possible exception of a new Army project on impulse noise.

CHAPTER II

NOISE EFFECTS RESEARCH

The effects of noise were broken down into various categories by the first Federal Interagency Noise Effects Research Panel, and for the sake of consistency the same categories have been maintained in the present Panel's deliberations. In those cases where slight changes were made in the titles of categories, reference will be made to the previous title. In the present report a category entitled "Human Response to Noise Concomitant with Vibration" was added since there appears to be new activity in this area.

The purpose of the many research projects discussed in this report is highly dependent upon the sponsoring agency's mission. However, in most cases the agencies are concerned with the development of criteria on the effects of various types of noise on humans or animals, with the eventual application toward the setting of standards, regulations or guidelines, the development of protective programs, the education of the public, or in some cases, the hope of rehabilitation.

The following paragraphs will provide a description of the categories and their component research topics, as they have been used by the previous and present Panels.

1. Noise-Induced Hearing Loss

This effect is the most widely researched, and the most well-documented of the effects of noise. It is also the most important in the sense that it is the nation's most prevalent occupationally-induced disease. The primary focus of research has been occupational noise, but increasing attention has been given to hearing loss resulting from non-occupational sources such as recreational pursuits, household products, and transportation vehicles. Much of the expenditure in this area is directed toward the description, mitigation and prevention of noise-induced hearing loss among Federal agency personnel (such as the Department of Defense).

The effects of 8-hour durations of moderate and high levels of occupational noise have been fairly well documented. There is also a growing body of information on longer durations, lower levels and various temporal patterns (including impulsive noise), but many gaps in the existing criteria need to be filled and many questions remain unanswered. The present controversy over proposals for revision of the noise regulation of the Occupational Safety and Health Administration makes more accurate statistical description of the cause-effect criteria relatively mandatory.

Current research on noise-induced hearing loss may be divided into laboratory and field projects. Considerable effort has been spent studying the basic mechanisms of noise-induced hearing loss in the laboratory. Microscopic sections of the inner ears of noise-exposed animals are examined in order to elucidate the physical and chemical process of cellular destruction. These studies sometimes include other toxic agents such as drugs or chemicals, to examine the combined effect. Since temporary threshold shift (TTS) is considered to be an indicator of potential permanent threshold shift (PTS) after years of exposure, controlled doses of continuous, intermittent and impulsive noise are given to animals and sometimes humans, with TTS as the dependent variable. TTS as well as various psychoacoustic measures are being tested as possible indicators of susceptibility to noise-induced hearing loss.

Since hearing impairment adversely affects one's hearing for speech, laboratory research is being conducted to determine the ability of individuals with noise-induced hearing loss to understand speech. Laboratory research is also being done to examine the protective capabilities of ear plugs and ear muffs.

Field research has largely consisted of cross-sectional studies of noise-exposed populations to determine the effects of various levels and durations of noise on hearing, and to test the effectiveness of ear protectors and hearing conservation programs. A longitudinal study of the development of normal hearing (and in some cases hearing loss) among children has recently been instituted.

2. Non-Auditory Health Effects

This category consists of the physiological effects of noise other than hearing damage. Although this area has been given considerable attention in Eastern Europe and the Soviet Union, relatively little research has been conducted in the U.S.

It is currently believed that noise acts as a biological stressor, producing and/or contributing to effects on the body that are typical of the so-called "stress diseases" (hypertension, ulcers, migraine headache, etc.). Transient effects, such as temporary rise of blood pressure or heart rate, have been produced in the laboratory, but these effects have not been thoroughly quantified, nor is it proven whether or not they become chronic after protracted exposure.

Laboratory studies in this area attempt to describe the relationship between noise exposure and various physiological parameters such as blood pressure, heart rate, hormonal secretion, and vestibular changes, both in animals and in humans. Limited research is being done on the effects of noise on the fetus in mammals, and also on the potentially damaging effects of infrasound on body organs. Epidemiological field studies are unfortunately very limited in Western countries and practically missing in the U.S.

3. Psychological and Performance Effects

The previous Panel referred to this category as "Individual Behavior Effects", but the present Panel preferred the above title as being somewhat more comprehensive. This area includes human reactions to noise as measured by verbal (and sometimes non-verbal) and behavioral responses. It includes the effects of noise on job performance. It may include subconscious or even automatic as well as conscious reactions to noise. Much of this research is conducted in the laboratory, but some studies, such as the effects of noise on job performance, are conducted in the field.

Research over recent years has shown that noise can disrupt the activities of daily life by degrading the performance of certain tasks. These performance degradations can sometimes lead to accidents, injuries and job inefficiency. The amount of degradation is related to the type and sensitivity of the task, the level and temporal nature of the noise, and the presence or absence of other stressors. Some tasks appear to be impervious to noise. An example of noise-induced performance degradation is the adverse effect of noise on teaching and learning behavior. Noise can also be a disruptive force in daily life because of its annoying or aversive properties, which can result in tension, anxiety and in some cases, antisocial behavior. Although these effects are fairly well documented, criteria in this area are far from complete.

Current research in this area involves laboratory and field studies of human reaction to levels, durations, spectral qualities and cognitive components of various noises. The studies include the effects of noise on task performance, and on physical, social, and mental behavior. They also include annoyance or aversiveness ratings of noise from various sources, such as highways and aircraft, and various types of noise such as impulsive noise and sonic boom.

4. Noise Effects on Sleep

Noise can disrupt sleep by causing individuals to awaken, or it can degrade the quality of sleep by causing them to shift into a lighter stage of sleep. While noise-induced sleep disruption is an annoying and prevalent occurance, the levels that produce awakening or changes in the quality of sleep appear to vary widely among individuals. Also, information is lacking on the after effects or consequences of noise-induced sleep disruption in terms of job performance, and degradation of health and well-being.

Recent research in this area is very limited. It includes a correlational analysis of existing sleep research data, and the effects of aircraft and traffic noise on sleep. The relation between noise and sleep quantity and quality, job performance and medical complaints is being studied in military environments.

5. Communication Interference

This category is primarily concerned with the effects of noise on speech communication but also includes the masking by noise of warning signals and other sounds necessary for the safe and efficient conduct of daily activities.

Speech communication can be extremely difficult in backgrounds of moderate to high noise level. Adequate communication environments can be important for formal education in schools, occupational efficiency, family life patterns, and quality of relaxation. Criteria for speech interference are fairly well defined, but traditionally have been based on speech generated in outdoor environments and perceived by individuals with normal hearing.

Much of the research in this area deals with requirements for adequate verbal communication in military and civilian aircraft and related activities. Studies are being conducted to determine the interfering aspects of noise on speech discrimination abilities of hearing-impaired as well as normal-hearing individuals. Research projects also include the determination of normal vocal effort in everyday noise backgrounds, and the development of noise criteria for various types of rooms and buildings.

6. Community or Collective Response

Studies in this category are directed toward the reaction of residential populations to noise environments in general and to certain noise sources in particular. They usually involve the administration of surveys or questionnaires, which are conducted in the field rather than the laboratory. Community reaction to noise may take a variety of forms, ranging from mild dissatisfaction with the neighborhood to complaints, threats, and organized legal action. Most of the surveys to date have dealt with aircraft and traffic noise, and results have usually been assessed in terms of numbers of people who report that they are highly annoyed or who are actively complaining.

Current research projects involve the development of a more sensitive and comprehensive method of evaluating the impact of noise on the community, extension of social surveys to neighborhoods impacted by sources other than aircraft noise, the assessment of the social and economic impact of noise, and the development and validation of guidelines for environmental impact statements.

7. Effects of Noise on Domestic Animals and Wildlife

In general, noise can have the same type of effects on animals as it does on humans. Since laboratory animals (such as rats, chinchillas, and monkeys) are almost always used as human surrogates, projects to study the effects of noise on these animals are discussed under the various preceeding categories. Of interest here are possible effects on farm animals which include changes in size, weight, reproductivity, and behavior. Effects of noise on wild animals may include changes in mating behavior, predator-prey relationships, and territorial behavior.

There is fairly little ongoing research in this area, with most of the projects directed toward the effects of noise on farm animals. One study entails a review of noise effects criteria in various species of wild and domestic animals.

8. Noise Environment Determination

The title for this category used by the previous Panel was "Measurement Methodology and Calibration". Since the category has been broadened to include noise exposure characterization the present title was selected.

Although the determination or description of noise environments is not strictly the assessment of a noise effect, it is a necessary step toward developing adequate criteria in all of the various categories. For example, before assessing the total impact of noise on the American population, the extent of the exposure problem must be quantified in terms of numbers of people exposed to various levels and durations of noise. In order to make these kinds of assessments and to use them in a meaningful way, standardized measurement techniques, instrumentaton, calibration procedures and rating schemes must be developed.

While the noise environment has been fairly well defined in many industrial and military settings, information is lacking on the noise exposure of the general public. Instrumentation for the measurement of noise exposure has become more sophisticated with the advent of integrating sound level meters and personally worn "dosimeters", the accuracy and versatility of which are still being refined. Computerized audiometric testing and calibration techniques have also been developed over recent years.

Current research projects in this category include the development and validation of sound level meters and dosimeters for specific measurement purposes, improvement of standard measurement techniques, and measurement of particular occupational environments.

9. Human Response to Noise Concomitant with Vibration

This is a new category to accommodate a small but growing body of research on the continued effects of noise and vibration generated by certain noise sources, such as aircraft and highways.

It has been determined that the annoyance, discomfort, and sometimes fear that is caused by noise sources is due, at least in part, to the vibration that is also generated from these sources. The relative contributions of the noise and vibration need to be assessed in order to derive criteria for the combined exposure conditions, and to mitigate the adverse effects.

CHAPTER III

NOISE RESEARCH PROGRAMS OF THE VARIOUS FEDERAL AGENCIES

Introduction

In order to present information on the perspectives of the various agencies on noise research, the following sections briefly summarize for each agency the general agency mission, the role of noise effects research in that mission, and current emphases in noise effects research. These narratives are followed by tables providing at-a-glance information on funding of noise effects research by category. In some cases one research project was concerned with more than one category, such as hearing loss, speech communication and calibration of instrumentation. For the sake of simplicity, these projects were "force-fit" into the category where the major emphasis seemed to be. In cases where it appeared that research efforts were evenly divided among categories, the funding levels were distributed accordingly.

Agencies

Department of Agriculture
Consumer Product Safety Commission
Department of Commerce (National Bureau of Standards)
Department of Defense (Air Force, Army, Navy)
Environmental Protection Agency (Office of Noise Abatement & Control, Office of Research & Development)
Energy Research and Development Agency
Department of Health, Education and Welfare (National Institute of Child Health & Human Development, National Institute of Environmental Health Sciences, National Institute of Neurological, and Communicative Diseases and Stroke, National Institute of Occupational Safety and Health)
Department of Interior (Bureau of Mines, Bureau of Reclamation, Mining Enforcement & Safety Administration)
Department of Labor (Occupational Safety & Health Administration)
National Academy of Sciences
National Aeronautics and Space Administration
National Science Foundation
Department of Transportation
Veterans Administration

The types of general missions of agencies represented on the Panel vary. Of the 23 organizational entities represented on the Panel, 18 are involved with research, 7 have regulatory responsibilities and at least half administer programs (in areas like transportation, health and welfare, national security, etc.) Of these at least seven combine all three types of missions.

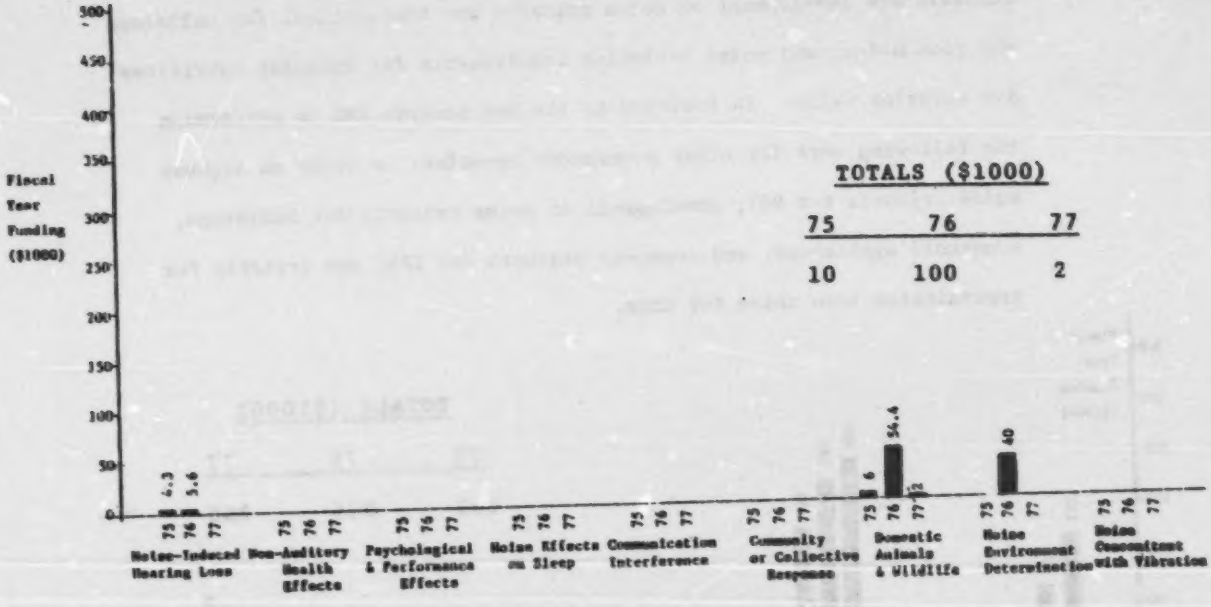
Turning to the question of the major way or ways in which noise effects research supports agency missions, protection of the hearing of the American people is a major concern. A query was directed to Panel members: How does noise effects research fit into your agency's general mission?" Responses could be sorted into the following categories:

	No. of Responses
Protection of hearing of the general public, including work force	14
Protection of general public from annoyance due to noise	9
Direct support of regulatory development	7
Protection of general public from noise from agency facilities	5
Hearing protection for own employees	3

DEPARTMENT OF AGRICULTURE

The Department of Agriculture is directed by law to acquire and disseminate information on agricultural matters and also to engage in research, conservation, and regulation in agricultural areas.

Most of USDA's noise effects related research is supported by the Federal grants program of the Cooperative State Research Service. Current areas of emphasis are hearing conservation programs for agricultural workers, and the effects of noise on farm animals.



TOTALS ($1000)

75	76	77
10	100	2

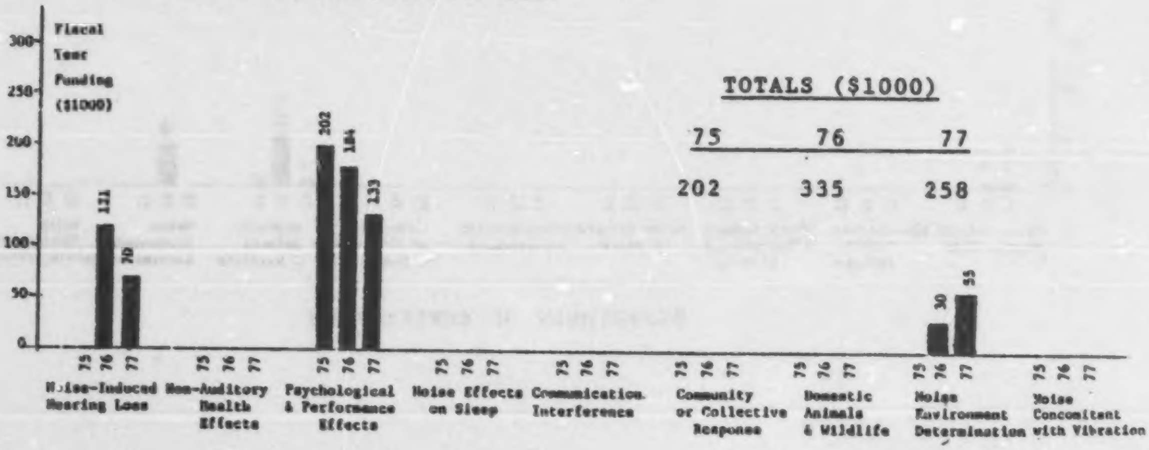
DEPARTMENT OF AGRICULTURE

DEPARTMENT OF COMMERCE

The National Bureau of Standards

The mission of the National Bureau of Standards is to advance the nation's science and technology and promote their effective application for the public benefit. NBS is responsible for the standardization of physical measurement systems, and conducts research to improve materials for technological application.

The main objective of the Bureau's noise effects research is to establish a psychoacoustical basis for noise measurement by identifying and quantifying human adverse response to noise. Current areas of emphasis are development of noise criteria for communities, for buildings and room noise, and noise isolation requirements for building partitions and exterior walls. In addition to its own program NBS is performing the following work for other government agencies: a study on highway noise criteria for DOT; development of noise criteria for buildings, household appliances, and consumer products for EPA; and criteria for transmission line noise for ERDA.



TOTALS ($1000)

75	76	77
202	335	258

NATIONAL BUREAU OF STANDARDS

CONSUMER PRODUCT SAFETY COMMISSION

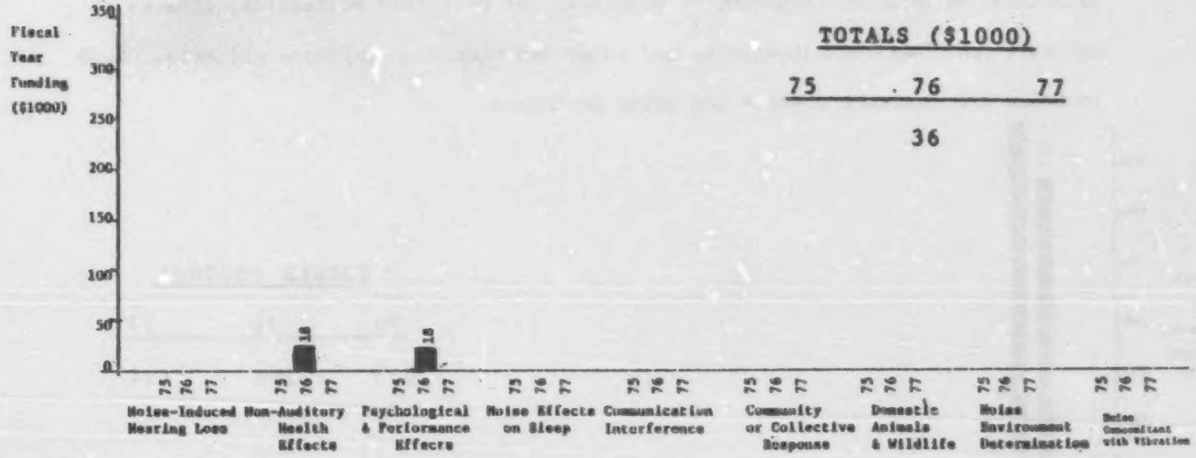
The Consumer Product Safety Commission is directed to:

- protect the public against unreasonable risks of injury associated with consumer products;
- assist consumers to evaluate the comparative safety of consumer products;
- develop uniform safety standards for consumer products and minimize conflicting state and local regulations; and
- promote research and investigation into the causes and prevention of product-related deaths, illnesses and injuries.

The Consumer Product Safety Act of 1972 and previous legislation constitute the Commission's mandate. The Commission issues mandatory safety standards and can ban hazardous consumer products. Part of its mission is the acquisition of information on noise effects associated with consumer products, sufficient for regulatory purposes.

TOTALS ($1000)

75	76	77
	36	



CONSUMER PRODUCT SAFETY COMMISSION

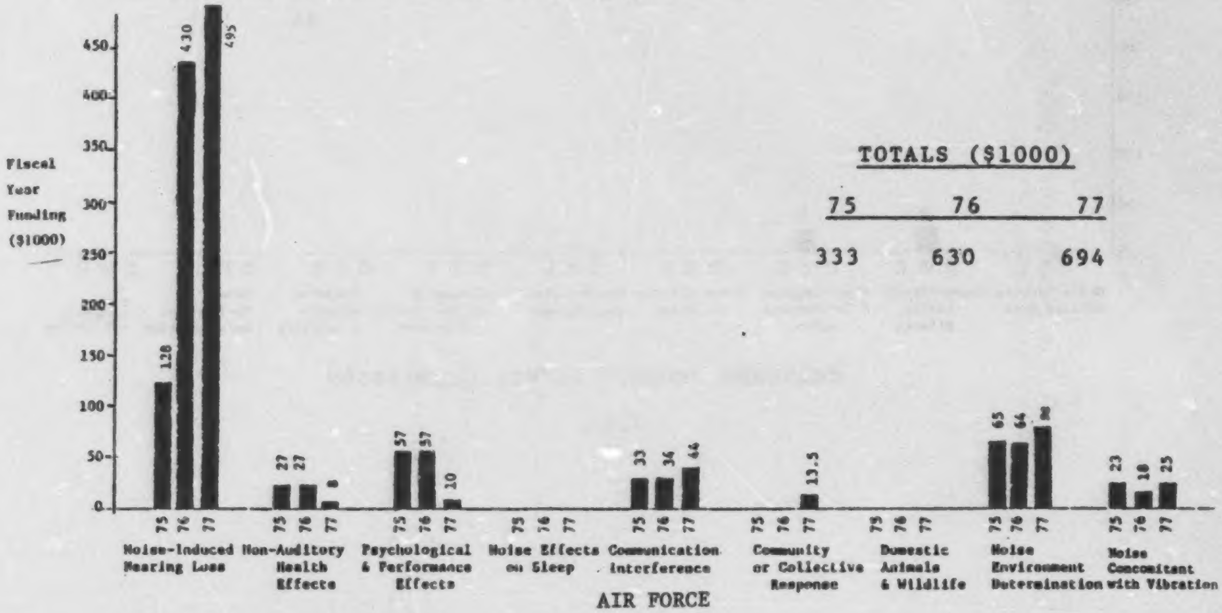
DEPARTMENT OF DEFENSE - Air Force, Army, Navy

The noise-effects research of DOD is directed to support mission needs including protecting the hearing and health of military personnel, insuring the performance capability and mission effectiveness of personnel in noise and combined noise and stress environments, and reducing the impact of peace-time military operations on the surrounding communities.

Air Force

Air Force biological acoustics research is primarily conducted in the research facilities of the Aerospace Medical Research Laboratory, Wright-Patterson AFB, Ohio. The Air Force hearing conservation program and related studies are the responsibility of the School of Aerospace Medicine, Brooks AFB, Texas. Both laboratories are under the Aerospace Medical Division, Air Force Systems Command.

Particular noise-related research emphases of the Air Force include: effects of long-duration continuous noise exposure, effects of high level and impulse noise, assessment of hearing conservation programs, ear protector evaluation, effects of aircraft noise on communications, and noise and vibration exposure criteria. Both in-house and contract studies are being performed.



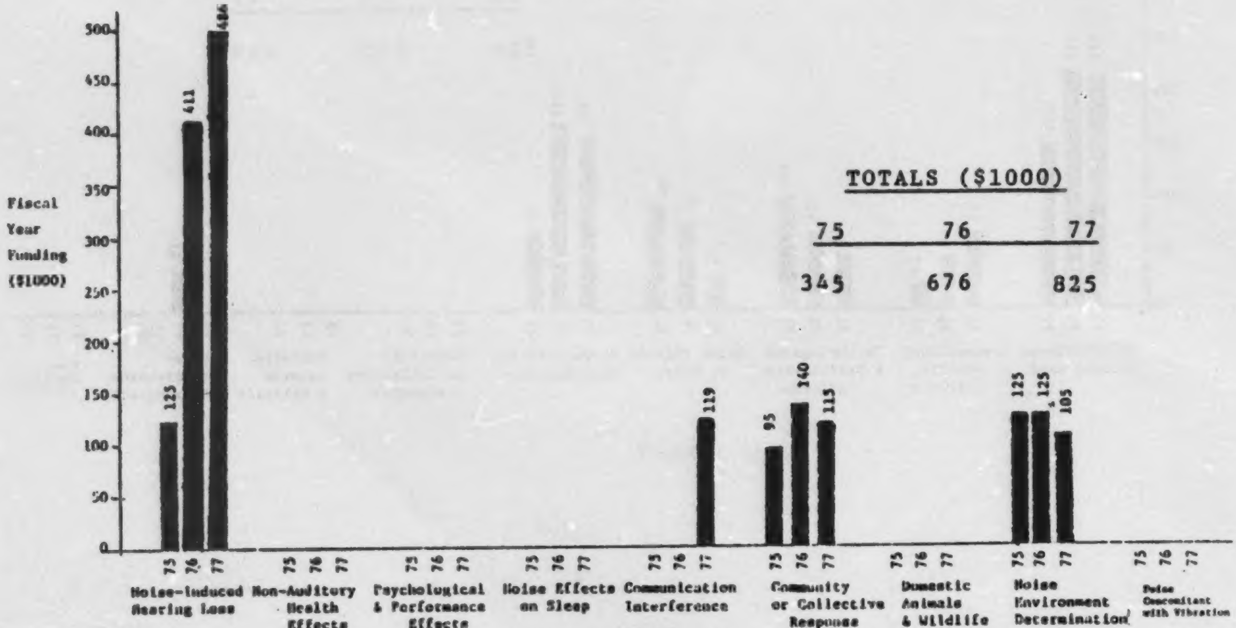
TOTALS ($1000)

75	76	77
333	630	694

AIR FORCE

Army

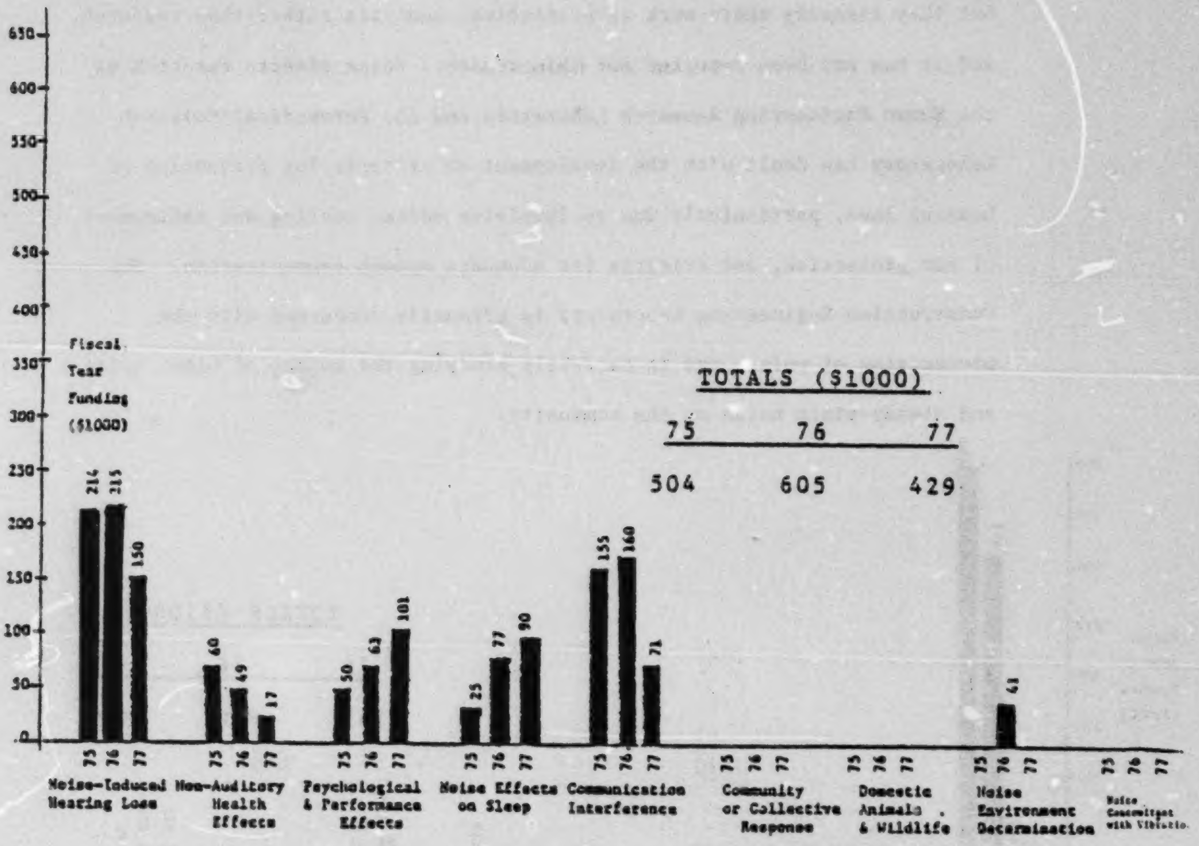
Research on the effects of noise is being performed at the Human Engineering Laboratory at Aberdeen Proving Grounds, Md., the Construction Engineering Research Laboratory, Champaign, Ill., and the Army Aeromedical Research Laboratory at Fort Rucker, Ala. The Army Environmental Hygiene Agency at Aberdeen Proving Grounds evaluates the environmental impact of noise on the community, and manages the Army's hearing conservation program, but they classify their work as statistical analysis rather than research, and it has not been reported for this reason. Noise effects research at the Human Engineering Research Laboratory and the Aeromedical Research Laboratory has dealt with the development of criteria for prevention of hearing loss, particularly due to impulsive noise, testing and refinement of ear protection, and criteria for adequate speech communication. The Construction Engineering Laboratory is primarily concerned with the propagation of noise, and is currently studying the impact of blast noise and steady-state noise on the community.



ARMY

Navy

Research and development areas receiving emphasis by the Navy during the current reporting period include: 1. the assessment and quantification of auditory and non-auditory risks associated with noise exposure in naval environments; 2. the optimization of personnel performance in high intensity acoustic environments; 3. the development of damage risk criteria for special military environments.



TOTALS ($1000)

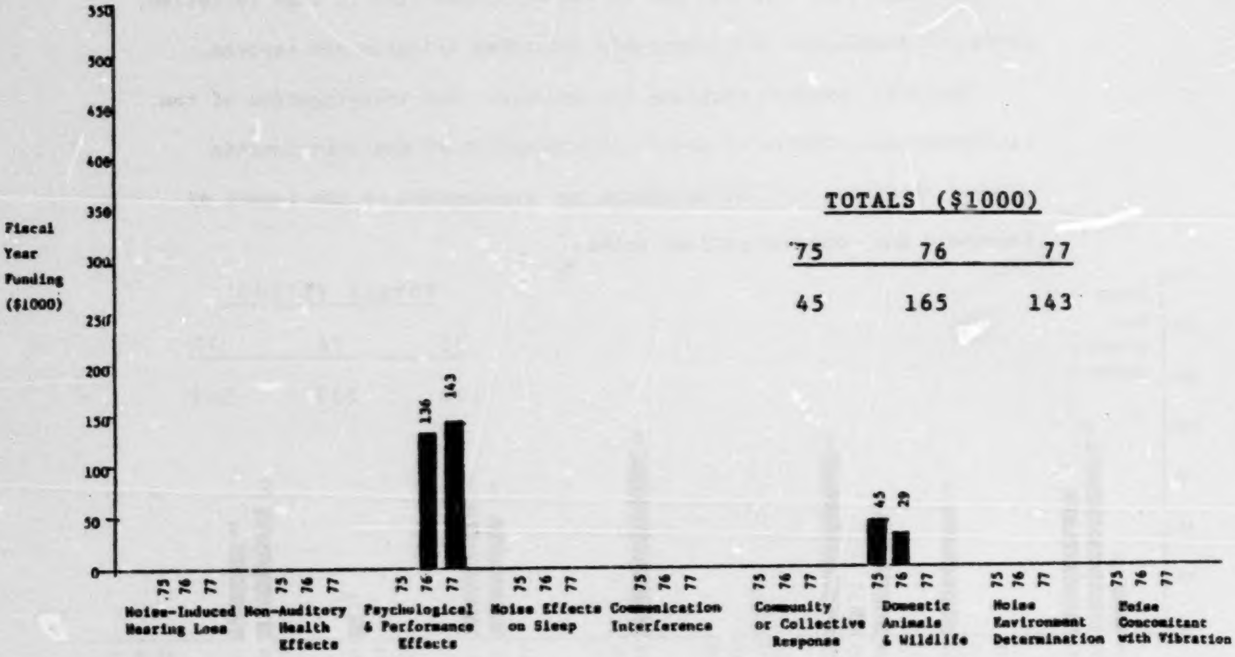
75	76	77
504	605	429

NAVY

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

ERDA was established in 1975 to consolidate under one agency activities relating to the research and development of various sources of energy. Its broad mandate is to "develop, and increase the efficiency and reliability of use of all energy sources to meet the needs of present and future generations...".

ERDA's limited noise effects research activities relate to its responsibility to enhance environmental quality while protecting the public's health and safety. Presently, there is one active project to develop criteria for adverse response to transmission line noise.



TOTALS ($1000)

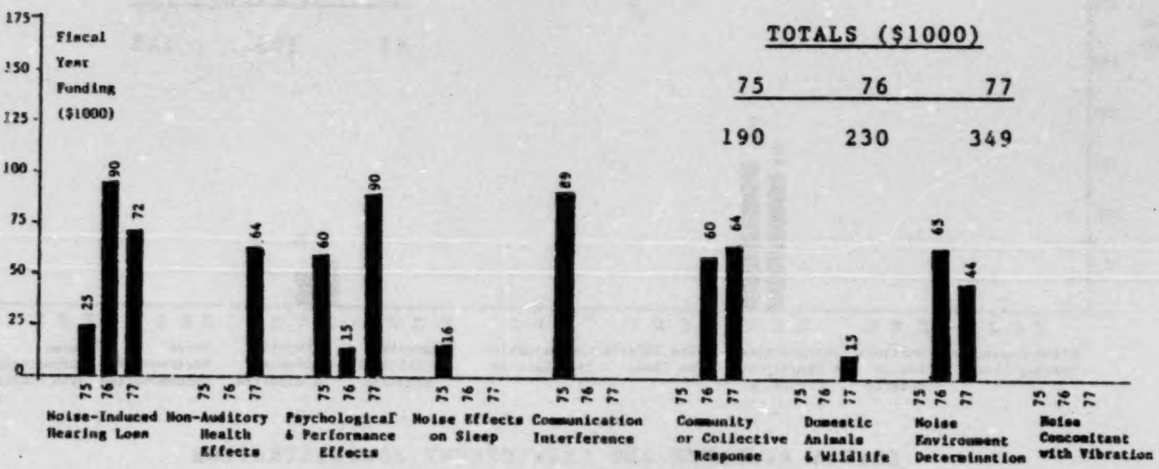
'75	76	77
45	165	143

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

ENVIRONMENTAL PROTECTION AGENCY

The Noise Control Act of 1972 mandates the Environmental Protection Agency to conduct and support financially research on noise, including the psychological and physiological effects of noise on humans and animals in order to determine acceptable levels of noise. The objective is to collect and evaluate health effects information for the development of noise regulating criteria, the provision of technical assistance to State and local governments and the dissemination of public information. Under the Act, EPA also issues product noise emissions regulations, coordinates the programs of all Federal agencies relating to noise research and noise control, and is required from time to time to review, revise or supplement its previously published criteria and reports.

Specific research emphases now include: the investigation of the cardiovascular effects of noise, investigation of the relationship between annoyance and intrusiveness and assessments of the impact of household and consumer product noise.



ENVIRONMENTAL PROTECTION AGENCY

DEPARTMENT OF HEALTH EDUCATION AND WELFARE

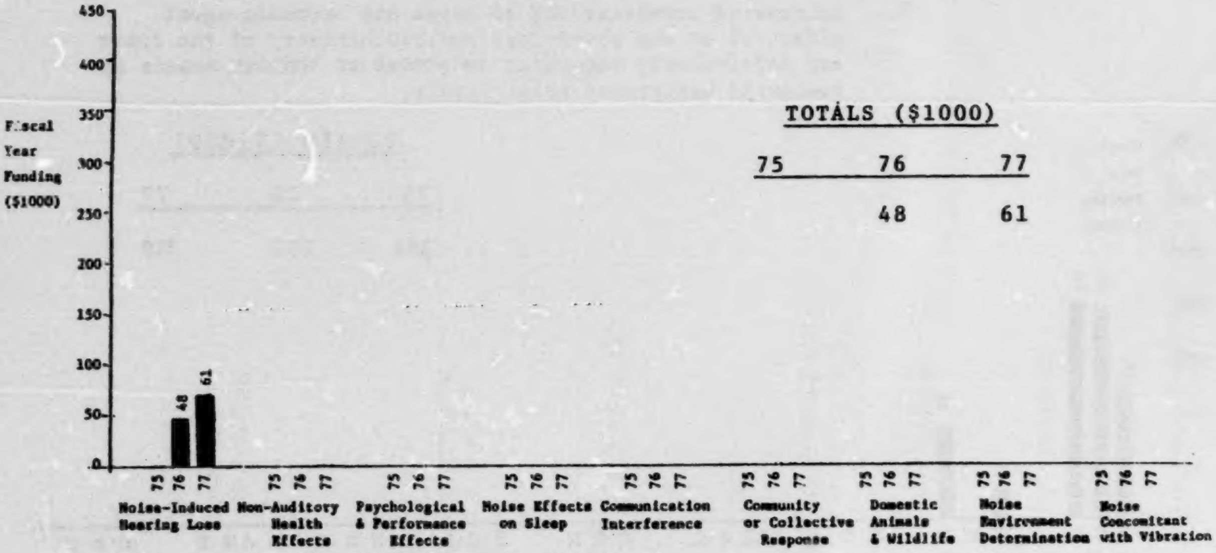
National Institutes of Health

The mission of National Institutes of Health is to improve the health of the American people through biomedical research.

National Institute of Child Health and Human Development (NICHHD)

The Institute conducts and supports biomedical and behavioral research on child and maternal health.

One study concerning the detection of auditory damage in the neonate was reported from NICHHD.



TOTALS ($1000)

75	76	77
	48	61

NATIONAL INSTITUTE OF CHILD HEALTH AND HUMAN DEVELOPMENT

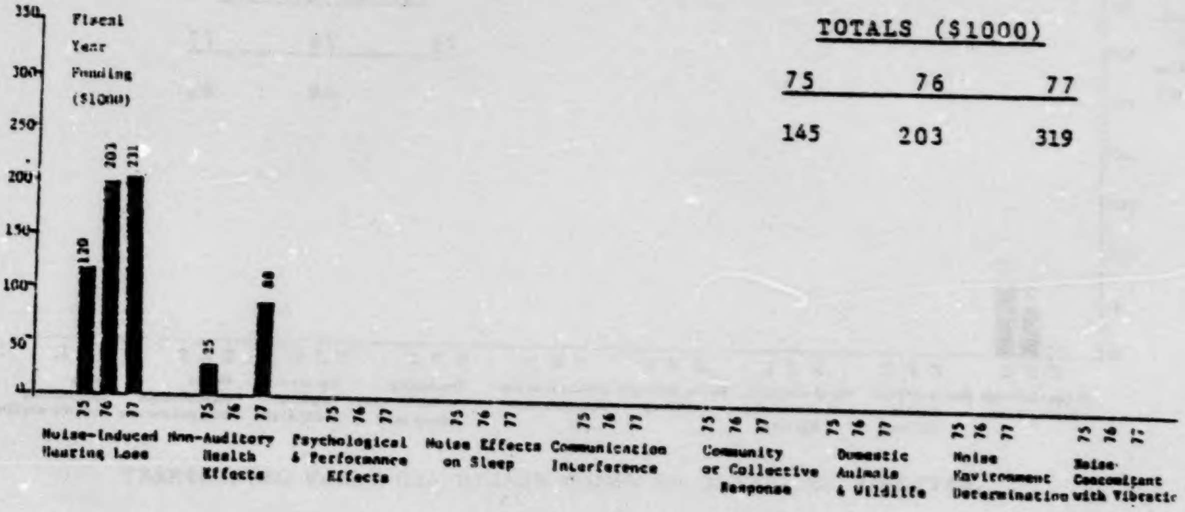
National Institute of Environmental Health Sciences (NIEHS)

The Institute conducts and supports fundamental research concerned with defining, measuring, and understanding the effects of chemical, biological, and physical factors in the environment on human health and well-being.

The general objectives of the NIEHS noise effects program are to increase understanding of the process by which noise damages the physiological, mechanical, biochemical and electroneural mechanisms of the ear and other parts of the body. The program also includes the identification of environmental agents that produce this damage, and the quantification of expected amounts of damage.

Two areas of noise effects research are currently emphasized:

1. Determining non-auditory (cardiovascular, teratogenic) effects of noise exposure.
2. Increasing understanding of noise and ototoxic agent effect(s) on the physiology and biochemistry of the inner ear particularly regarding responses to complex sounds in realistic background noise levels.



TOTALS ($1000)

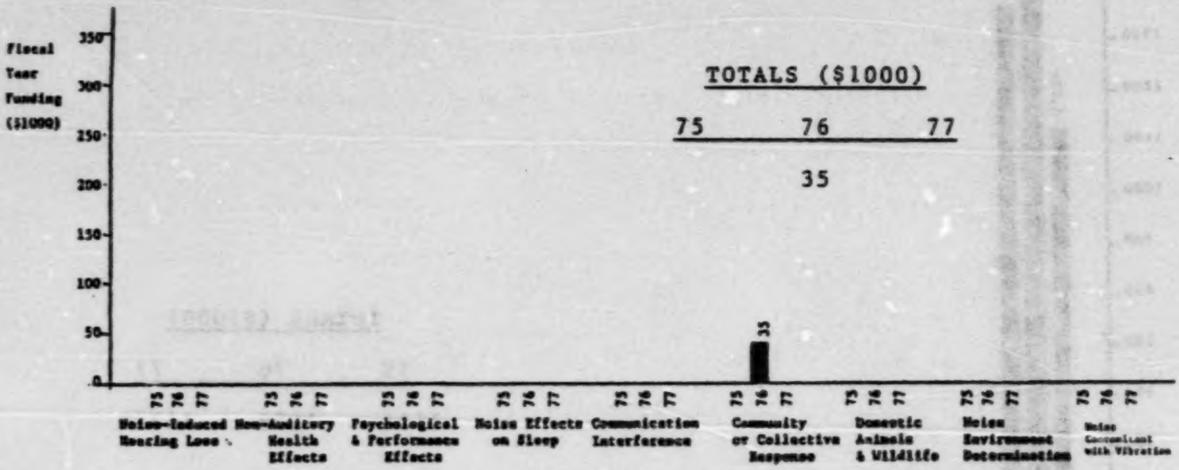
75	76	77
145	203	319

NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

National Institute of Mental Health (NIMH)

The Institute serves as the principal agency for the study of behavioral science and the cultural and social problems related to mental health.

NIMH reported one recently completed study that investigated emotional and behavioral responses of community residents to highway construction noise.



TOTALS ($1000)

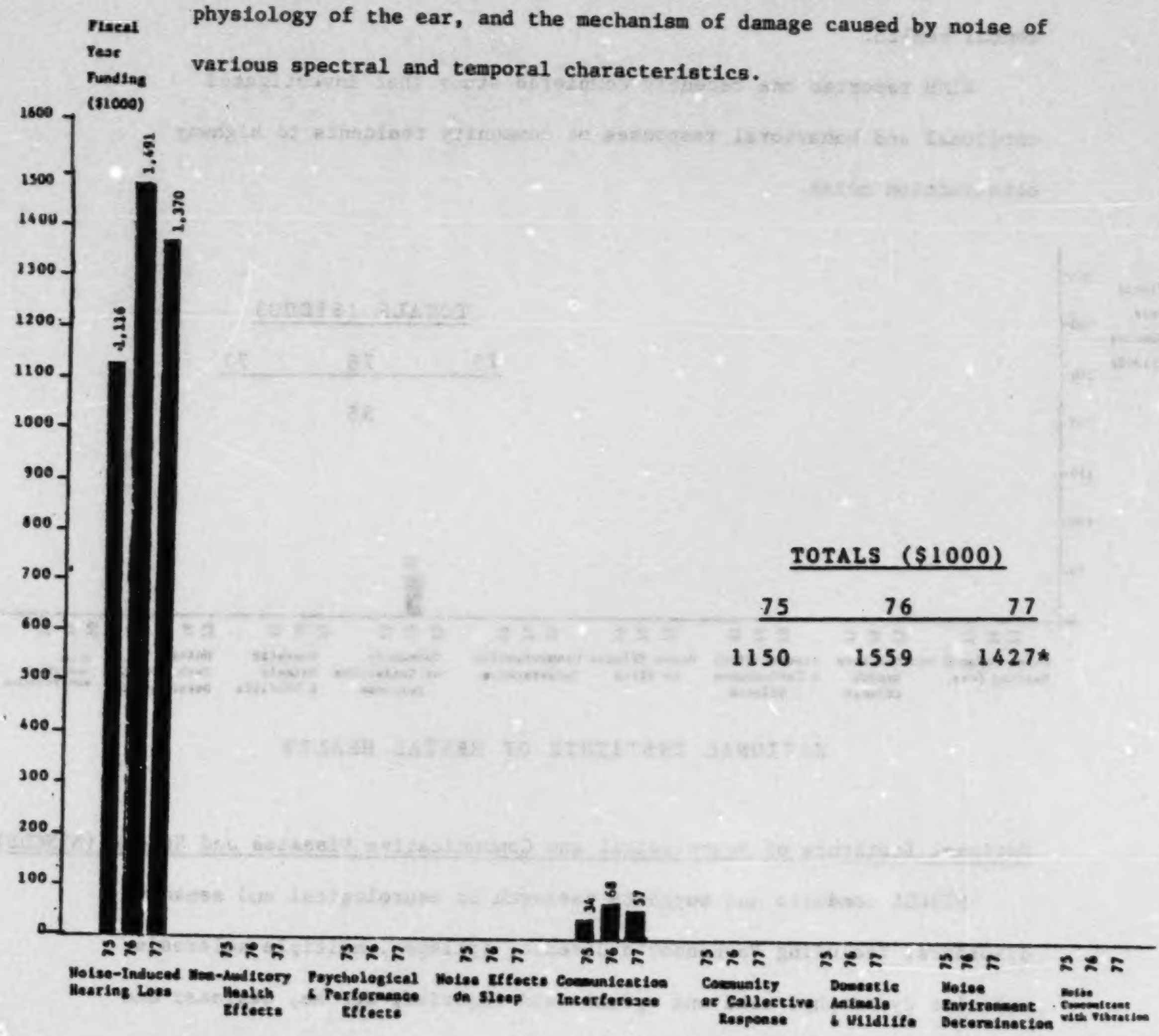
75	76	77
	35	

NATIONAL INSTITUTE OF MENTAL HEALTH

National Institute of Neurological and Communicative Diseases and Stroke (NINCDS)

NINCDS conducts and supports research on neurological and sensory disorders, including Parkinson's disease, epilepsy, multiple sclerosis, muscular dystrophy, head and spinal cord injuries, stroke, deafness and other communicative disorders.

Its noise effects research focuses on the effects of noise on the auditory system. Current research covers a wide range of topics such as susceptibility to hearing loss, the relationship of temporary threshold shift to permanent threshold shift, cochlear and vestibular effects, and duration/intensity functions. Many projects deal with normal and abnormal physiology of the ear, and the mechanism of damage caused by noise of various spectral and temporal characteristics.



TOTALS ($1000)

75	76	77
1150	1559	1427*

NATIONAL INSTITUTE OF NEUROLOGICAL AND COMMUNICATIVE DISEASES AND STROKE

* Some of the NINCDS projects cover more than noise effects alone. Therefore, the funding data for these projects may overestimate actual monies spent for research solely on noise effects.

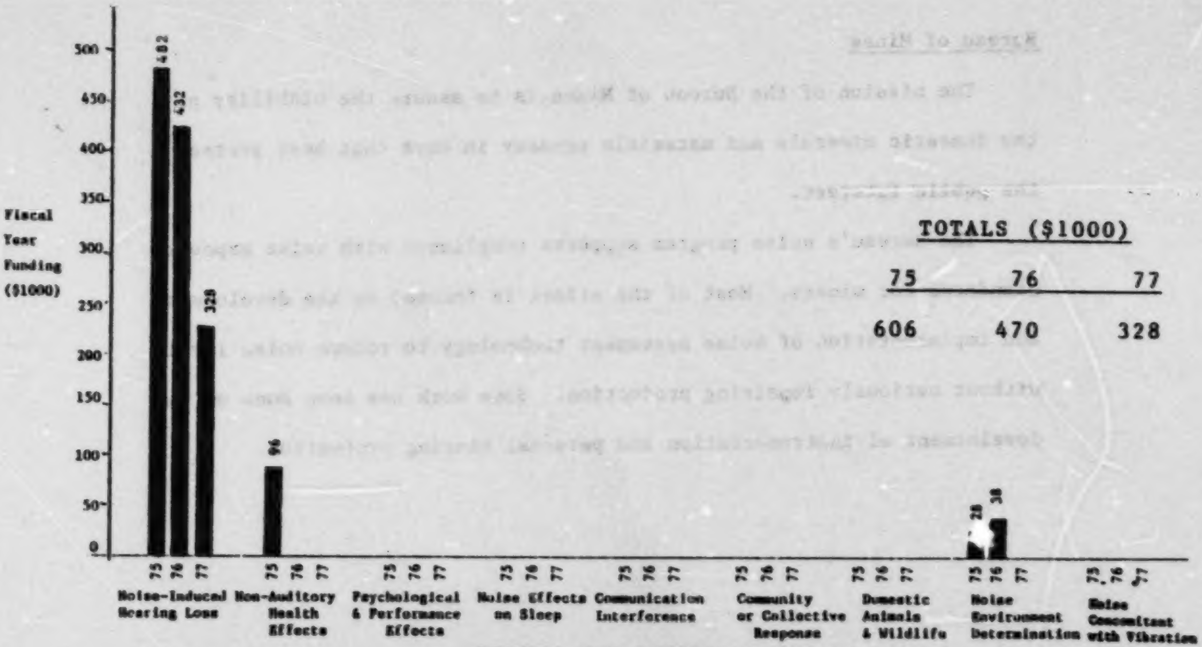
Center for Disease Control

National Institute for Occupational Safety and Health (NIOSH)

The National Institute for Occupational Health and Safety is directed to perform research leading to criteria for safe and healthful workplace conditions by authority of the Occupational Safety and Health Act of 1970 and the Federal Coal Mine Safety and Health Act of 1969. Noise is one of the many agents investigated for deleterious effects on health and safety.

NIOSH has conducted numerous field and laboratory studies to determine the relationship between workplace noise of various intensities and durations to the incidence and magnitude of hearing loss.

Current research emphasizes criteria for impulsive and intermittent noise. Hearing conservation measures including ear protective devices are also being evaluated.



TOTALS ($1000)

75	76	77
606	470	328

CENTER FOR DISEASE CONTROL

NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH

DEPARTMENT OF INTERIOR

Bureau of Mines, Bureau of Reclamation, Mining Enforcement and Safety Administration

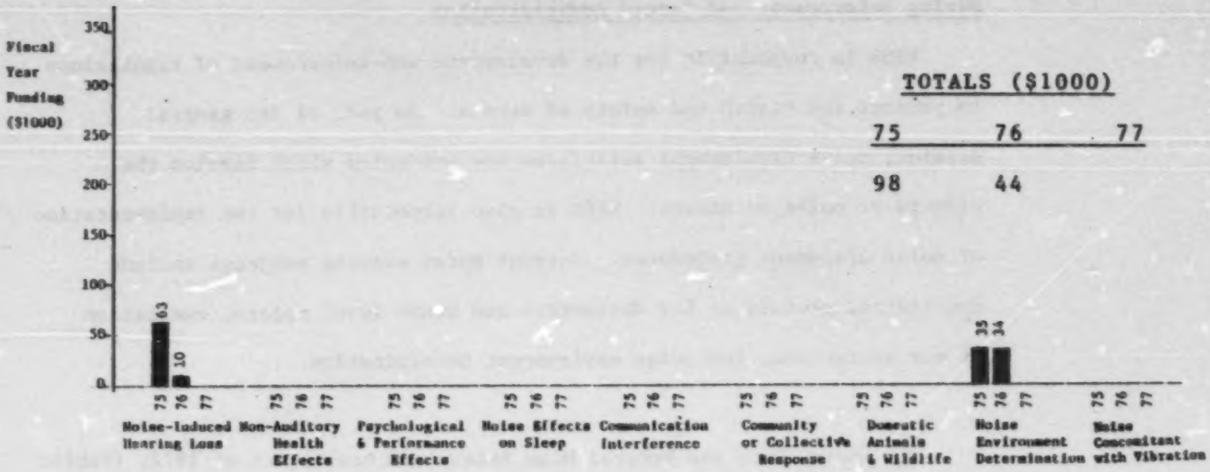
The primary responsibility of the Department of Interior is the management, conservation and development of the nation's natural resources, including Federal lands and trust lands, fish and wildlife, water, fuel and minerals.

The noise effects research being undertaken by the Department of Interior is mainly directed towards hearing conservation for miners in compliance with the Federal Coal Mine Health and Safety Act of 1969 and the Federal Metal and Non-Metallic Mine Safety Act of 1966. These Acts led to establishment of mandatory standards prescribing maximum noise exposure levels for underground and surface mines.

Bureau of Mines

The mission of the Bureau of Mines is to assure the viability of the domestic minerals and materials economy in ways that best protect the public interest.

The Bureau's noise program supports compliance with noise exposure standards for miners. Most of the effort is focused on the development and implementation of noise abatement technology to reduce noise levels without seriously impairing production. Some work has been done on the development of instrumentation and personal hearing protection.



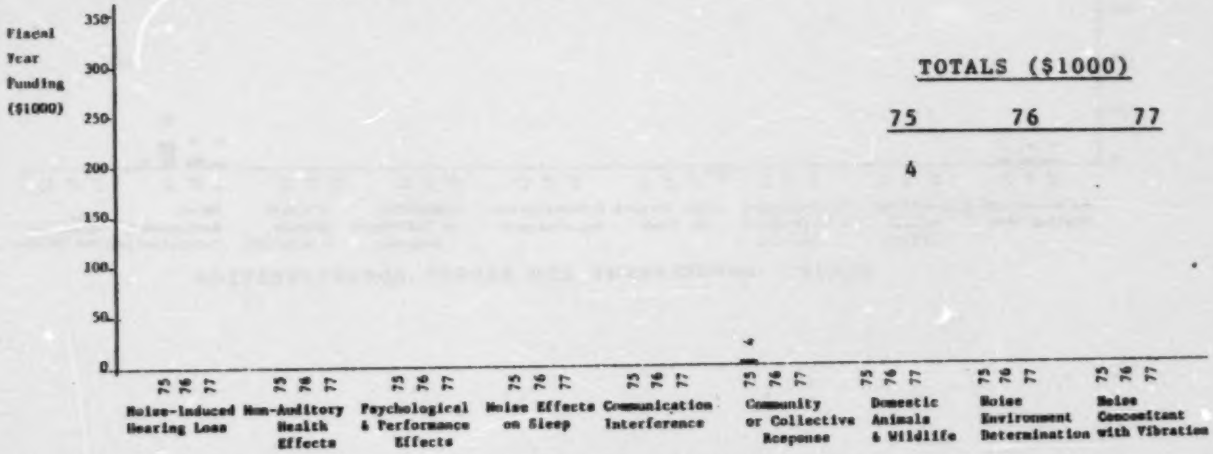
TOTALS ($1000)

75	76	77
98	44	

BUREAU OF MINES

Bureau of Reclamation

The Bureau of Reclamation is responsible for the development and operation of water works for the reclamation of arid and semi-arid lands in western states. The Bureau has one study related to the effects of noise entitled, "Noise Abatement in Substations."



TOTALS ($1000)

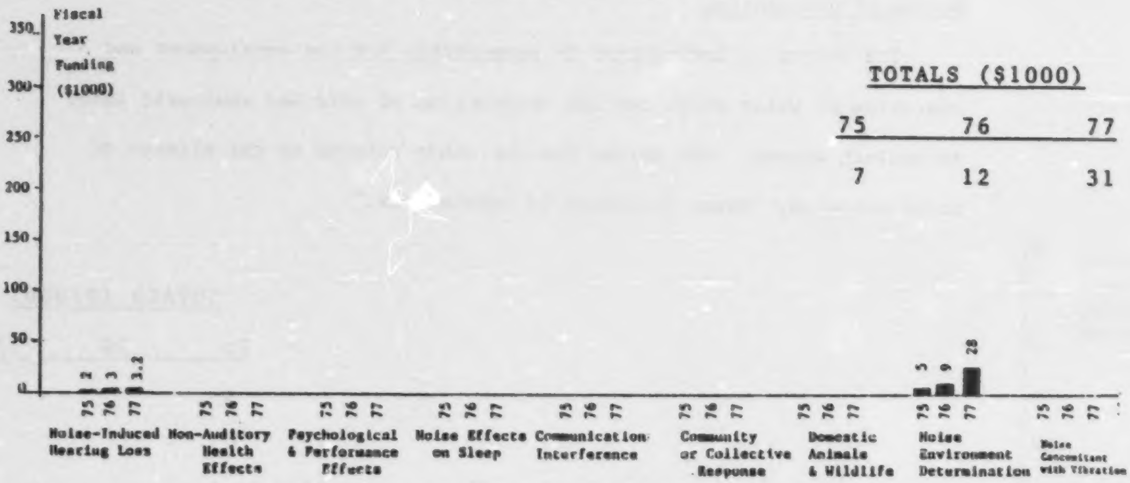
75	76	77
4		

BUREAU OF RECLAMATION

Mining Enforcement and Safety Administration

MESA is responsible for the development and enforcement of regulations to protect the health and safety of miners. As part of its general mission, noise development activities are conducted which involve the effects of noise on miners. MESA is also responsible for the implementation of noise abatement procedures. Current noise effects projects include calibration procedures for dosimeters and sound level meters, evaluation of ear protectors, and noise environment determination.

In accord with the Federal Mine Safety and Health Act of 1977, (Public Law 95-164) effective March 9, 1978, the Mining Enforcement and Safety Administration will become the Mine Safety and Health Administration and be transferred to the Department of Labor.



TOTALS ($1000)

75	76	77
7	12	31

MINING ENFORCEMENT AND SAFETY ADMINISTRATION

DEPARTMENT OF LABOR

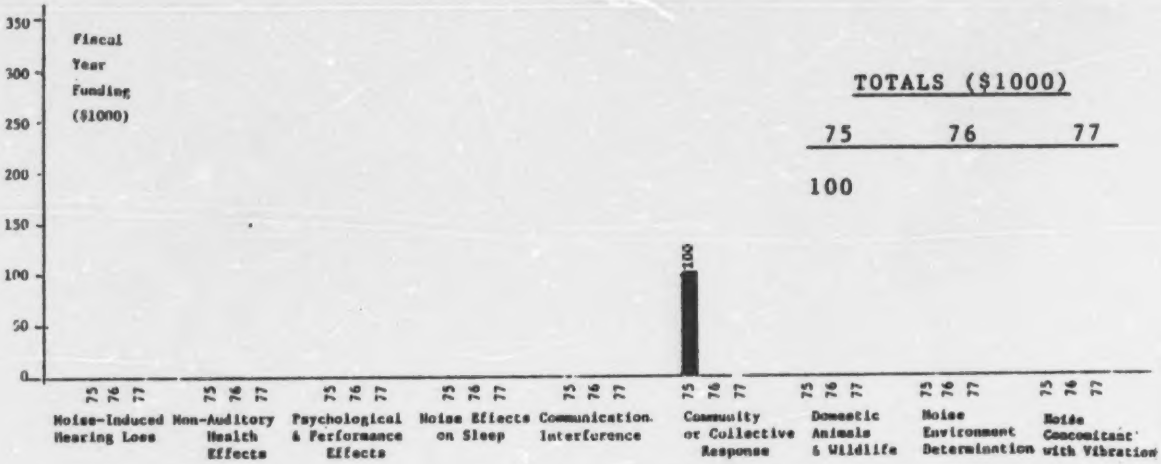
Occupational Safety and Health Administration (OSHA)

The Occupational Safety and Health Administration was established in 1970 to develop, promulgate and enforce occupational health and safety standards and regulations. In 1971 OSHA issued an occupational noise exposure standard. Although OSHA did not report any noise effects research, a representative was included on the panel because of OSHA's important regulatory role, and reliance on research for criteria to set standards.

NATIONAL ACADEMY OF SCIENCES

The mission of the National Academy of Sciences is to stimulate scientific research and its application to the public welfare. The Academy brings together a group of eminent scientists and engineers who may be consulted by government agencies on matters of public policy.

Within the last three years one noise-related research project was sponsored by the Transportation Research Board of the National Research Board of the Academy concerning the development of a model to determine the economic impact of traffic noise.



TOTALS ($1000)

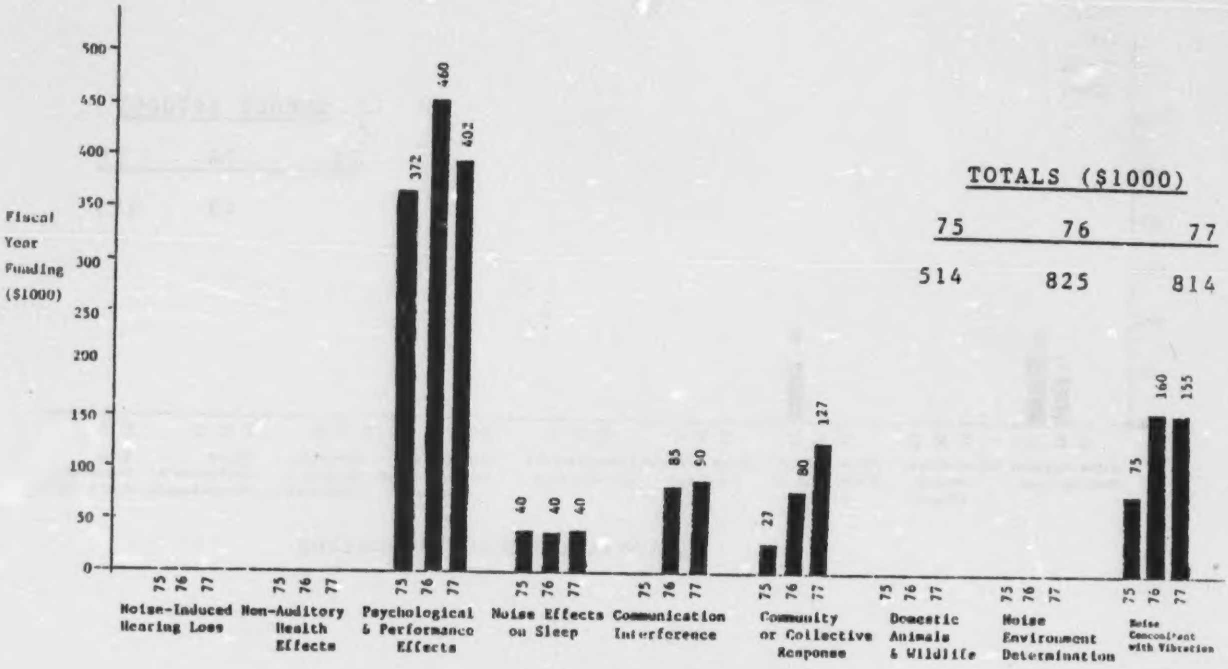
75	76	77
100		

NATIONAL ACADEMY OF SCIENCES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

The National Aeronautics and Space Administration conducts research related to the problems of flight, develops and tests aeronautical and space vehicles, and conducts the nation's space exploration program.

NASA's noise effects research program is located at the Langley Research Center in Virginia. Both in-house and contract studies are being performed. Laboratory and field studies investigate community annoyance and adverse subjective responses caused by aircraft noise, and the combination of noise and vibration.

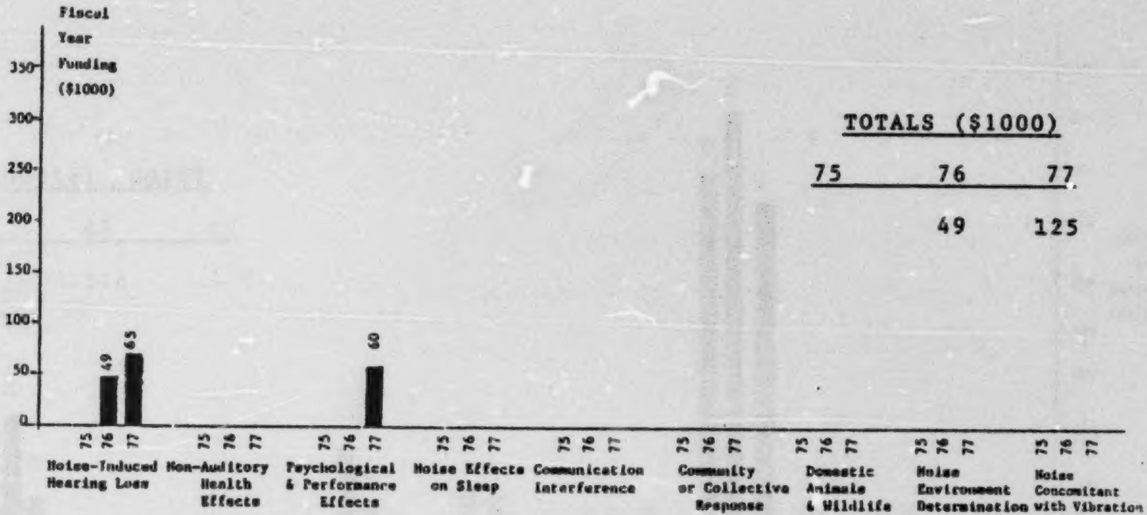


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NATIONAL SCIENCE FOUNDATION

The National Science Foundation was established in 1950 to stimulate scientific research, to promote international cooperation through science and to help develop science education programs. The NSF initiates and supports fundamental and applied research in all scientific disciplines.

Noise effects research projects currently funded by NSF include investigations of the effects of noise and aging on cochlear physiology, and the relationship between noise levels in the home and the classroom on the health and behavior of children.



TOTALS ($1000)

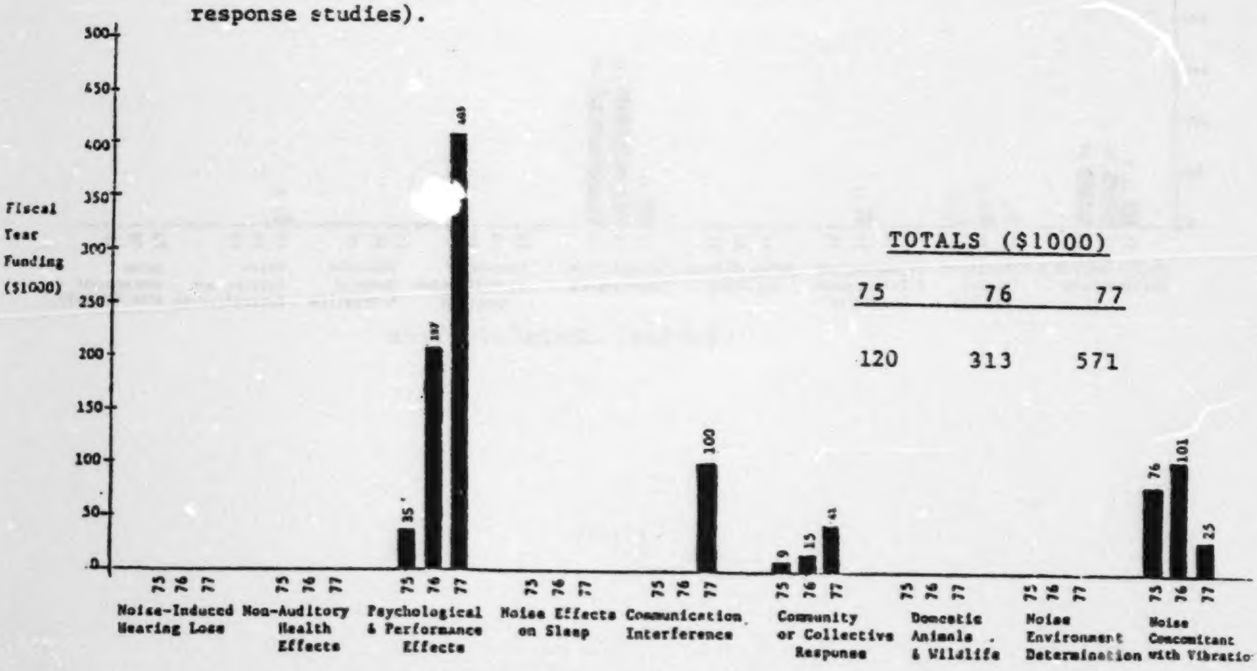
75	76	77
	49	125

NATIONAL SCIENCE FOUNDATION

DEPARTMENT OF TRANSPORTATION

The Department of Transportation's mission is to assure the coordinated, effective administration of the transportation programs of the Federal government, and to develop national transportation policies and procedures conducive to the provision of safe, fast, efficient and convenient transportation.

DOT's noise effects research is concerned with assessing the impact of transportation noise on the public and on vehicle operators. Principle noise effects research projects in 1977-78 include a study for improving noise descriptors for human response to time-varying traffic noise and an evaluation of descriptors for perceived noisiness for use in conjunction with aircraft noise certification. In addition, there are current projects in communication interference (effects of noise in aircraft cockpits) and in community or collective response (Concorde opinion surveys; feasibility of a personal noise exposure index for use in community response studies).



TOTALS ($1000)

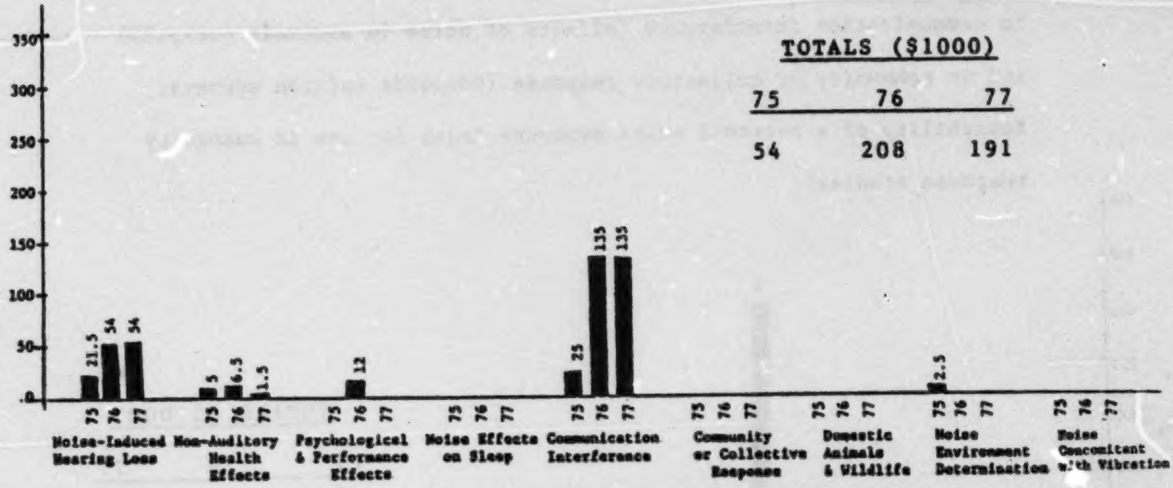
75	76	77
120	313	571

DEPARTMENT OF TRANSPORTATION

VETERANS ADMINISTRATION

The Veterans Administration administers laws covering a wide range of benefits for former members, and dependents and beneficiaries of deceased members, of the Armed Forces. The VA includes a health care system of more than 170 hospitals and 200 clinics.

The VA's noise-related research program provides support to its Audiologic Service, whose duties are the diagnosis and rehabilitation of Veterans' hearing problems, and the determination of disability claims. Current noise-related research includes investigations of the interaction of noise and antibiotic drugs, loudness discomfort levels, and the effects of noise on the communication abilities of hearing-impaired people.



VETERANS ADMINISTRATION

CHAPTER IV

SUMMARY TABLES AND COMPARISONS WITH PREVIOUS PANEL'S FINDINGS

In this chapter summary tables and graphs will be presented, which show funding levels for noise effects research by category and by agency. The figures represent total expenditures over the fiscal years 1975, 1976 and 1977, of the individual agencies listed in Chapter III. Also presented are the annual funding levels identified by the First Federal Noise Effects Panel compared to the annual funding levels identified by the Second Panel. The First Panel's identified research topics in need of additional emphasis will be listed and brief statements will be made as to the extent that current research projects address these topics.

Funding by Category

Table 1 gives funding levels for fiscal years 1975, 1976, 1977, and 1978 estimates for each noise research category. Figure 1 portrays the same information graphically. It appears that there was slightly more funding in FY 77 than in previous years, but the trend is not consistent in each category. Noise-induced hearing loss received considerably more funds than the other areas.

Funding by Agency

Table 2 shows funding levels for fiscal years 1975, 1976, 1977, and 1978 estimates for noise effects research according to agency. Figure 2 gives the same information graphically. It can be seen that the Department of Defense and two of the agencies within the Department of Health, Education and Welfare (NINCDS and to a less extent NIOSH) provide most

Table 1

NOISE EFFECTS RESEARCH FUNDING BY CATEGORY

(In Thousands of Dollars)

Category	FY 75	FY 76*	FY 77	3 YEAR TOTALS	EST. FY 78
Noise Induced Hearing Loss	2,300	3,563	3,385	9,248	4,116
Non-Auditory Health Effects	213	101	179	493	226
Psychological & Performance Effects	776	1,143	1,344	3,263	1,127
Noise Effects on Sleep	81	117	130	328	130
Communication Interference	336	482	616	1,434	394
Community Collective Response	235	330	361	926	347
Domestic Animals & Wildlife	51	83	17	151	15
Noise Environment Determination	261	445	330	1,036	655
Noise Concomitant with Vibration	174	279	205	658	375
TOTALS	4,427	6,543	6,567	17,537	7,385

*Includes transition quarter funding.

Table 2

NOISE EFFECTS RESEARCH FUNDING BY AGENCY

(In Thousands of Dollars)

Agency	FY 75	FY 76*	FY 77	3 YEAR TOTALS	Est. FY 78
Department of Agriculture	10	100	2	112	0
Consumer Product Safety Commission	0	36	0	36	0
Department of Commerce (NBS)	202	335	258	795	247
Department of Defense (AF)	333	630	694	1,657	795
(Army)	345	676	825	1,846	2,210
(Navy)	504	605	429	1,538	429
Environmental Protection Agency (ONAC) (ORD)	190	230	349	769	350
Energy Research and Development Administration	45	165	143	353	143
Department of Health, Education, and Welfare (NICHHD)	0	48	61	109	0
(NIEHS)	145	203	319	667	202
(NIMH)	0	35	0	35	0
(NINCDS)	1,150	1,559	1,427	4,136	1,426
(NIOSH)	606	470	328	1,404	247
Department of Interior (BOM,BOR,MESA)	109	56	31	196	89
National Academy of Sciences	100	0	0	100	0
National Aeronautics and Safety Administration	514	825	814	2,153	740
National Science Foundation	0	49	125	150	72
Department of Transportation	120	313	571	1,004	250
Veterans Administration	54	208	191	453	185
TOTALS	4,427	6,543	6,567	17,537	7.385

* Includes transition quarter funding.

FIGURE 1

NOISE EFFECTS RESEARCH

FUNDING BY CATEGORY FOR FISCAL YEARS 1975, 1976 and 1977

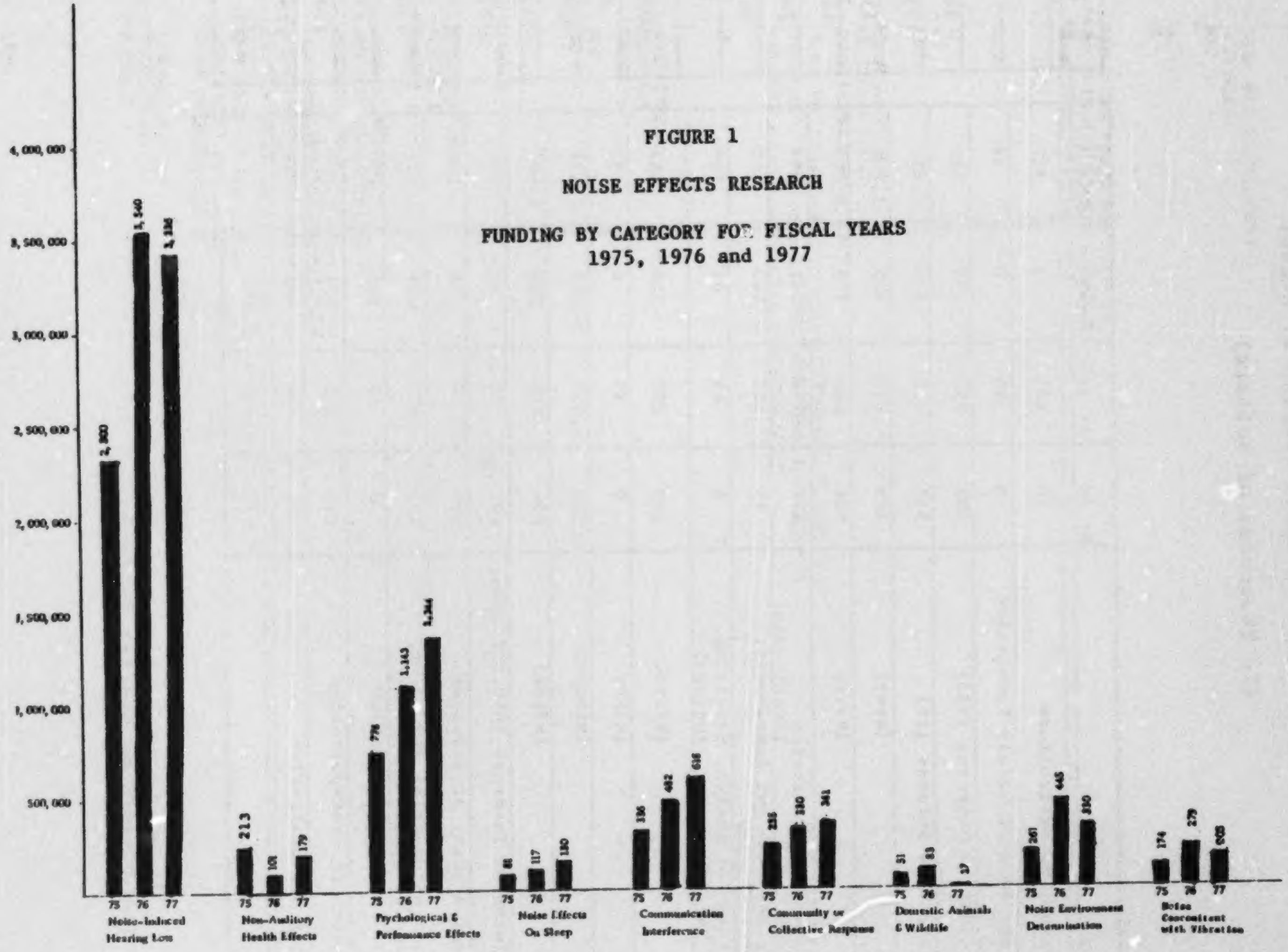
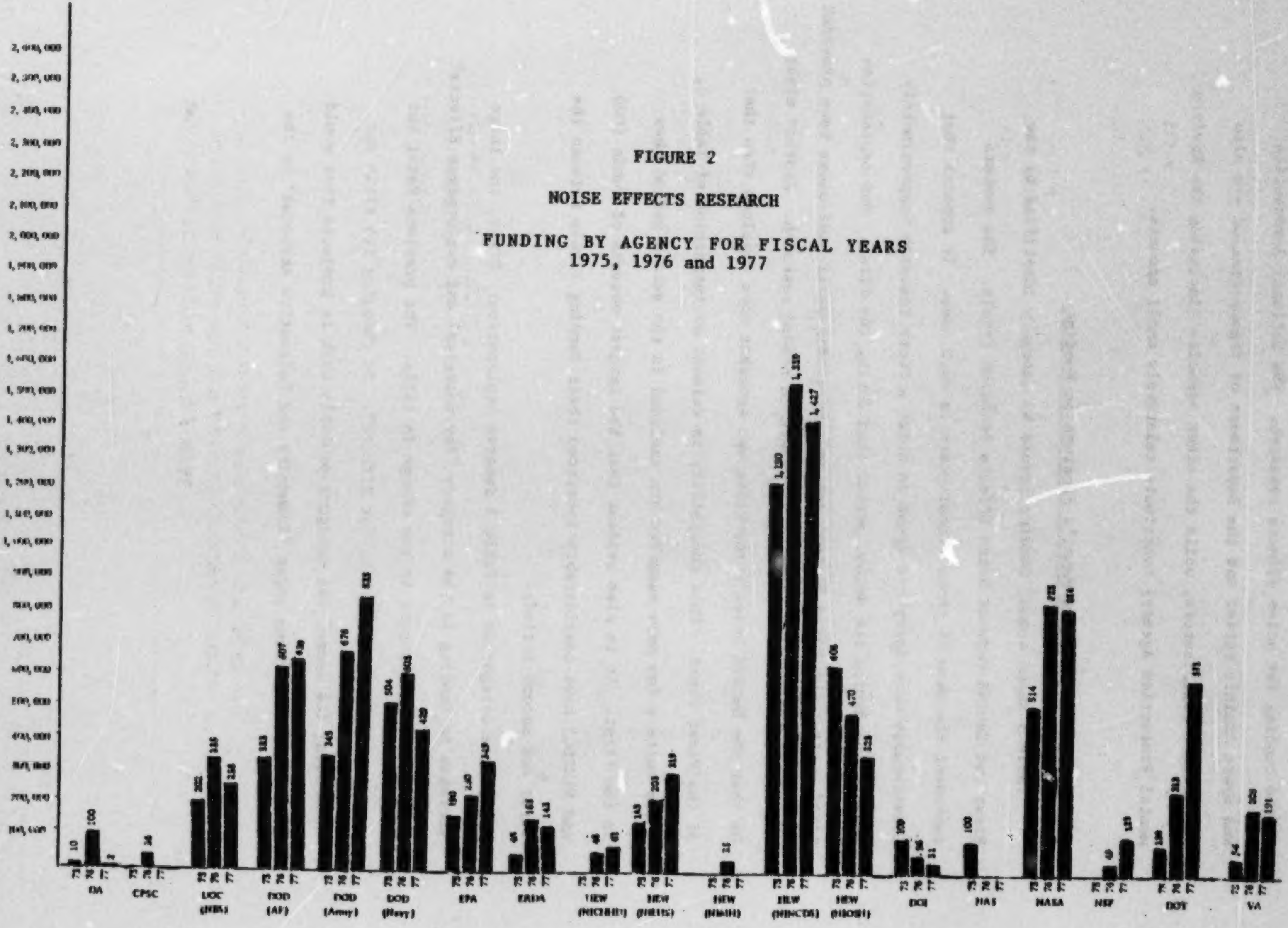


FIGURE 2

NOISE EFFECTS RESEARCH

FUNDING BY AGENCY FOR FISCAL YEARS 1975, 1976 and 1977



of the funding for noise effects research. The National Aeronautics and Space Administration and the Department of Transportation are also significant contributors, while the other agencies (including the Environmental Protection Agency) contribute relatively small amounts.

Comparison with Previous Panel's Findings on Funding

Table 3 shows annual funding levels by category identified by the First and Second Federal Noise Effects Research Panels. The numbers represent the mean of three fiscal years in each case. It appears that considerably more money was spent on noise effects research (approximately $2 million) during the second period than during the first. One explanation might be that the Noise Control Act and increasing public awareness have provided a stimulus for several agencies to embark on needed research. Another might be that the Second Panel's reporting was somewhat more complete than that of the First Panel. This possibility is evident on inspection of Table 4, where quite a few more agencies are included in the second period than in the first. It is also evident that the largest sources of funds (DOD and NINCDS) have considerably increased their funding levels between the first and second periods.

Three categories in Table 3 deserve explanation: First, the large increase in funding in the category "Psychological and Performance Effects" is probably due in part to the change in title. The previous Panel had entitled it "Individual Behavior Effects". By changing its title and broadening its scope, the category probably took in projects that would have been categorized under "Community and Collective Response" by the

Table 3

Trends in Funding by Category

COMPARISON OF NOISE EFFECTS RESEARCH FUNDING BY CATEGORY REPORTED BY FIRST AND SECOND PANELS

(In Thousands of Dollars)

Category	FY 73 - FY 75 (mean)	FY 75 - FY 77 (mean)
Noise Induced Hearing Loss	1,391	3,082
Non-Auditory Health Effects	161	164
Psychological & Performance Effects	276	1,088
Noise Effects on Sleep	147	109
Communication Interference	309	478
Community Collective Response	626	309
Domestic Animals & Wildlife	0	50
Noise Environment Determination	1,076	338
Noise Concomitant with Vibration	(new category)	219
TOTALS	3,986	5,837

Table 4

Trends in Funding by Agency

COMPARISON OF NOISE EFFECTS RESEARCH FUNDING BY AGENCY REPORTED BY FIRST AND SECOND PANELS

(In Thousands of Dollars)

Agency	FY 73 - FY 75 (mean)	FY 75 - FY 77 (mean)
Department of Agriculture	(not reported)	37
Consumer Product Safety Commission	(not reported)	12
Department of Commerce (NBS)	130.3	265
Department of Defense (AF, Army, Navy)	948	1,679
Environmental Protection Agency (ORD, ONAC)	237	256
Energy Research and Development Administration	(not reported)	118
Department of Health, Education and Welfare (NICHHD)	(not reported)	36
(NIEHS)	216.3	222
(NIMH)	(not reported)	12
(NINCDS)	768.5	1,379
(NIOSH)	395	468
Department of Housing and Urban Development	405	(not reported)
Department of Interior (BOM, BOR, MESA)	32 (BOM only)	65
National Academy of Sciences	(not reported)	33
National Aeronautics and Space Administration	802	718
National Science Foundation	7	58
Department of Transportation	77	334
Veterans Administration	(not reported)	151
TOTALS *	4,018	5,843

* Totals differ slightly from those of Table 3 because of rounding errors.

earlier Panel. Secondly, the apparent decrease in funding for the "Community and Collective Response" category is due, at least in part, to the same process. Thirdly, the decrease in funding in the "Noise Environment Determination" category is largely due to the termination of a large study by NASA to characterize noise from V/STOL aircraft.

Consideration of Previous Panel's Recommendations

The following paragraphs will outline the research topics that were identified by the First Noise Effects Research Panel as needing additional emphasis. A brief statement will follow on the degree to which each of these needs is currently being addressed by federal programs. The implications of these statements should be interpreted with caution. The fact that much of the Federal government's current research does not directly apply to the First Panel's recommended areas of emphasis should not be interpreted as a sign that such research is not important. Also, the fact that research has in some cases been initiated that addresses the First Panel's recommendations does not necessarily mean that the gap is filled. In addition, it does not necessarily mean that present work originated in response to the recommendations. Many data points are usually needed in order to draw close-response curves.

Areas Identified by the First Panel as Needing Additional Emphasis	Related Current Federal Research Program
A. Noise-Induced Hearing Loss	
1. Longitudinal Studies of Normal Hearing	A longitudinal study on normal hearing in children initiated under the joint sponsorship of the Air Force and EPA. Also, audiometric data are now being recorded on normal-hearing as well as hearing-impaired Air Force personnel.
2. Longitudinal Studies of Noise Exposed Populations	Data on noise exposed populations are now being recorded by the Air Force. However, it is not considered feasible (or ethical) to collect longitudinal data on the effects of high levels of noise on unprotected ears. Hence, studies must be limited to examining the effectiveness of hearing conservation programs.
3. Analysis of Cross-Sectional & Retrospective Audiometric Data from Known Occupational Exposure	NIOSH is currently funding a study on impulsive noise in Poland, and is planning a study on intermittent noise in the paperworking industry.
4. Definition and Quantification of Presbycusis	Some research in this area is being funded by NINCDS, the VA, and the NSF.
5. Possible High-Risk and Susceptible Populations	A study to investigate susceptibility is currently being funded by EPA, and a subpart of the NIOSH study of paperworkers may include a susceptibility parameter. The DOD continues to study the effects of noise on military personnel in possible high-risk conditions such as hyperbaric environments. Some work on possible susceptibility of the fetus to noise-induced hearing loss has been initiated by the Air Force on conjunction with the EPA.
6. Social & Economic Impact of Noise-Induced Hearing Loss	No federally sponsored research is being conducted on this topic.
B. Non-Auditory Health Effects	
1. Non-Auditory Long-Term Health Effects	
a. Epidemiologic (physiological and mental health)	NIOSH has completed a contract study on the effects of noise on absenteeism and accident rates in an industrial population. This study was under way during the meetings of the previous Panel.
b. Longitudinal Studies on Subhuman Primates	EPA and NIEHS have recently funded a study on protacted noise exposure and cardiovascular effects in rhesus monkeys.

Areas Identified by the First Panel as Needing Additional Emphasis	Related Current Federal Research Program
2. Health Effects of Impulse Noise	No federally sponsored research*.
3. Health Effects of Infrasound Ultrasound	Limited work in this area is being done by the Navy to determine the effects of infrasound on lung tissue.
C. Psychological and Performance Effects (formerly Individual Behavior Effects)	
1. Effects on Task Performance in in Specific Environments	The NIOSH study on absenteeism and accident rates also applies to the above topic in that accidents represent performance decrements. The Air Force continues to study the effects of noise, and the combined effects of noise and vibration on task performance.
2. Pure-Tone and Time-Varying Corrections for Annoyance Evaluation	Studies in this area are being sponsored by a number of agencies including EPA, NBS, NASA and DOT, but the problems of tonal and durational corrections are not always the primary focus. NASA is sponsoring a study on the effects of duration on human response to aircraft noise. NBS is performing (under DOT's sponsorship) a study of human response to time-varying traffic noise.
3. Effects of Noise in Learning Situations	The NSF is currently funding research on the effects of noise in the classroom and in the home on the health and performance of children.
4. Annoyance in Susceptible Populations (e.g. hospital environments)	No federally sponsored research.
5. Cognitive Components of Annoying Noise	NASA is sponsoring a study to assess the effects of fear and emotions on human response to aircraft noise.
D. Noise Effects on Sleep	
1. Chronic Sleep Interruption by Noise	Noise is one of the factors affecting sleep patterns in a Navy-sponsored study that is exploring the relationship between chronic sleep disruption and job performance and medical complaints.
2. Sleep Interruptions on Special Populations (ill, aged, etc.)	No Federally sponsored research.

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* This finding predated the start of a large Army program on the auditory and non-auditory effects of impulse noise.

Areas Identified by the First Panel as Needing Additional Emphasis	Related Current Federal Research Program
E. Communication Interference	
1. Everyday Speech Communication in Real-Life Noise Situations	
a. Various vocabularies	No federally sponsored research.
b. Various Populations (children, females, aged, foreign dialect, hearing-impaired, etc.)	Research on the effects of noise on speech communication abilities of elderly people is currently being conducted by the VA. The VA and NINCDS are sponsoring research on the adverse effects of noise on speech discrimination of hearing-impaired individuals.
2. Criteria for Speech Communication in Rooms	Research projects in this area are being conducted by NBS and sponsored by EPA. An EPA-sponsored study in speech levels in various environments (living rooms, department stores, classrooms, etc.) was recently completed.
3. Effects of Noise on Speech and Message Production	No federally sponsored studies.
4. Effective of Auditory Warning Signals in the Presence of Noise	The DOT (through the Coast Guard) is funding a study to determine the relationship between noise and operator performance of small boats.
F. Community or Collective Response	
1. Community Surveys to Address Annoyance as a Function of Exposure Patterns	The DOD continues to assess annoyance as a function of exposure pattern around military sites. In addition, the EPA has recently completed an analysis of the survey data from a large urban population, and the design of a survey questionnaire that can be used by local communities to assess annoyance due to noise.
2. Noise, Its Sociological Effects in Relation to Quality of Life	The DOT and the NIMH have funded small studies in this area, and the NAS has recently completed a project on valuation and compensability of noise pollution.
3. Criteria for Land Use Compatibility	No federally sponsored studies.
G. Effects of Noise on Domestic Animals and Wildlife	
1. Identification and development of criteria with respect to behaviorial effects of: a. Endangered species b. Other Wildlife c. Domestic Animals	What limited research that is being done in this area is mainly concerned with domestic animals (particularly fowl) and is sponsored by the Department of Agriculture. ERDA has sponsored a study on the effects of geothermal noise on wildlife, and EPA has sponsored a criteria review on the effects of noise on wildlife.

Areas Identified by the First Panel as Needing Additional Emphasis	Related Current Federal Research Program
H. Noise Environment Determination (formerly Measurement Methodology and Calibration)	
1. Development of standard methodologies	Research is being conducted by NIOSH and MESA to develop standard techniques for assessing occupational noise exposure, performing industrial audiometry, and calibrating instrumentation.
2. Characterization of noise in terms of environmental impact	Guidelines for the preparation of environmental impact statements on noise have recently been published under the sponsorship of EPA and the Air Force.
3. Characterization of noise effects of specific sources	NASA and the DOT continue to support research to characterize the effects of aircraft noise. The EPA is currently attempting to characterize the effects of motorcycle noise and household and consumer product noise.
4. Development of monitoring instrumentation for evaluation of complex noises	NIOSH and MESA are currently funding the development of dosimeters, calibrators for the assessment of occupational noise exposure.

CHAPTER 5

PANEL'S RECOMMENDATION AND CONCLUSIONS

The Panel's recommendations are based on a review and discussion of the Federal Noise Effects Research Program documented in Appendix B of this report and on a general, although not always detailed, familiarity of most panel members with non-government funded research efforts (Appendix C) and foreign research (reported separately as EPA report No. 550-9-78-101 Foreign Noise Research in Noise Effects, January 1978).

Consideration of current research projects supported by the various Federal agencies leads to the conclusion that the previous Panel's recommendations are being addressed only to a limited extent. Although certain research projects appear to respond to the identified areas needing additional emphasis, sometimes only one or two projects are being conducted (as in the case of non-auditory long-term health effects), and sometimes none (as in the case of sleep disturbance in special populations, and the non-auditory health effects of impulse noise). Funding in some categories, such as non-auditory health effects has remained static, and in others such as community or collective response, it has actually decreased, although additional research in these areas was clearly required and recommended.

In order to assess the present Panel's opinions on the sufficiency of current Federal expenditures and the extent to which current research needs on the effects of noise are being met the Panel members were questioned on a variety of issues. They were asked to allocate funds as if there were absolutely no budget restrictions ("blue skies" funding).

Then they were asked to redistribute funds among the research categories given present levels of funding. (Fiscal 1976 figures were used as a reference because of their completeness at the time). They were also asked to recommend levels of emphasis for current research topics (but not individual projects), according to whether funding for topics should be increased, decreased or maintained at present levels.

The following paragraphs are an attempt to summarize the Panel's recommendations. They represent a fairly good consensus of the members' opinions in most cases, although it was not unusual for one or two members to disagree. Where a consensus was not achieved it will be noted.

Recommendations Regarding Funding Levels

Agreement was virtually unanimous that funding for noise effects research should be increased over present levels. When unlimited funding was hypothesized, recommendations ranged from increases of less than 1% to as much as 600%. The median recommended increase was about 40% over all categories, with noise-induced hearing loss receiving the smallest increase and non-auditory health effects receiving the largest. The consensus also held that research on animals and on noise concomitant with vibration was fairly adequate at present levels, while research on community response and sleep interference needed considerably more funding. There was no research area in which the Panel felt an absolute decrease in resources was called for.

When the members were asked how they would distribute funds if only FY 76 funds were available, the consensus was to considerably increase funding for non-auditory health effects, and to slightly increase funding in all other categories (with the exception of psychological and performance effects) at the expense of research on noise-induced hearing loss. It should be kept in mind that this action represents a forced choice, rather than the ideal condition. It certainly does not mean that research topics in this area are not extremely important. The number of topics on noise-induced hearing loss that were identified as high priority is a positive indication of that fact. Instead, it appears that most Panel members would prefer a redistribution of funds within that category with increased emphasis on the topics listed below. It also probably reflects the fact that the majority of Panel members represented agencies with regulatory and standards responsibility which gave priority to information on noise effects criteria to satisfy regulatory needs, frequently in the near term time frame. The long-term benefits from fundamental research on basic effects mechanisms and from an understanding of the causes of the observed dose-response relationships received second priority, therefore, in this forced-choice approach--mainly since only one agency (HEW) considered this basic research part of its primary mandate.

Identification of Research Topics Needing Emphasis

Topics within categories were rated as to whether they should receive increased, level or decreased emphasis. The following topics represent a consensus of opinion for increased emphasis*:

1. Noise-Induced Hearing Loss
    - Effects of noise on children
    - Effects of impulsive and intermittent noise
    - Longitudinal studies of hearing in normal and noise-exposed populations
    - Relationship between temporary and permanent threshold shift
    - Possible high-risk and susceptible populations
    - Social and economic impact of noise-induced hearing loss.
2. Non-Auditory Health Effects
    - Cardiovascular and other physiological changes due to noise (short-term) in the general population.
    - Worker safety and health.
    - Long-term non-auditory health effects
    - Non-auditory health effects of impulse noise.
3. Effects of Sleep
    - Effects of chronic sleep interruption by noise
    - Effects of sleep interruption on special populations (e.g. ill, aged, etc.)
4. Communication Interference
    - Prediction of speech intelligibility in noise
    - Everyday communication in lifelike noisy environments
    - Effects of noise on speech and message production.

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* The order in which topics are listed is not intended to indicate the order of importance.

5. Community or Collective Response

   a. National baseline data bank on environmental noise exposure levels

   b. Sociological effects of noise in relation to quality of life

6. Noise Environment Determination

   a. Development of standard methodologies to measure and characterize the effects of noise

   b. Audiometry (standardized methods and calibration)

There was moderate consensus on research topics that should be continued at present levels of funding. These topics include nearly all of the topics identified by the previous panel, which have not already been listed as high priority topics above. Only a few topics were considered candidates for decreased emphasis. Those topics included research to determine hearing levels in fowl, the effects of noise on drug uptake, and the effects of military operations noise on communities.

Summary

The Panel was virtually unanimous (with one abstention) in its agreement that increases in present levels of funding for noise effects are needed in order to fill existing information gaps in the Federal noise program. A majority of the members believed that substantial increases are needed over present funding levels. It was agreed that noise effects information is needed not merely to advance the state of knowledge in this area, but to provide solid criteria on which standards, regulations, ordinances, and educational and technical assistance programs can be based for the effective protection of the public. Without adequate criteria, such standards and programs cannot be expected to be adequately protective, cost-effective and defendable in court.

Although the Panel's charge included noise effects research only, the Panel noted that vibration effects for the occupational situation as well as for the communities exposed to street traffic, aircraft and impulse noise concommitant with vibration deserve additional attention. Since vibration and noise environments are frequently closely coupled, emanating from the same basic source, it would behoove agencies to reevaluate their responsibility with respect to such vibration effects research programs.

Two areas that have been recognized by both Panels as needing more research are: the effects of noise on sleep and on community response. Funding levels however have actually decreased since the last Panel's deliberations.

The research area most clearly identified as needing immediate and substantial emphasis was that of non-auditory health effects. It is an area where criteria are non-existent, but where public concern is increasingly focused due to the findings of some European studies and some preliminary research in this country, which have been cited repeatedly in the news media. It is also an area of need that had been identified by the previous Panel, but the Panel's recommendation must have gone unnoticed (or ignored) since funding levels have not changed. Funding of this area appears mandatory for several years until authoritative definitive studies on this subject exist which allow the assessment of the magnitude of this problem area. Once this magnitude has been determined, its relative importance with respect to auditory health effects area should be reassessed.

APPENDIX A

Noise Effects Research Panel Members

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APPENDIX B

PROJECT SUMMARIES

Agencies

Agriculture, Dept. of

Commerce, Dept. of
    National Bureau of Standards

Consumer Product Safety Commission

Defense, Dept. of
    Air Force
    Army
    Navy

Energy Research and Development Administration

Environmental Protection Agency (Office of Research Development, Office of Noise Abatement & Control)

Health, Education and Welfare, Dept. of
    National Institute of Child Health and Human Development
    National Institute of Environmental Health Sciences
    National Institute of Mental Health
    National Institute of Neurological and Communicative Diseases and Stroke
    National Institute of Occupational Safety and Health

Interior, Dept. of
    (Bureau of Mines, Bureau of Reclamation, Mining Enforcement and Safety Administration)

National Academy of Sciences

National Aeronautics and Space Administration

National Science Foundation

Transportation, Dept. of

Veterans Administration

DEPARTMENT OF AGRICULTURE

NOISE-INDUCED HEARING LOSS

Agricultural Safety Engineering

One portion of this project is to develop a hearing conservation program for workers in agricultural processing industries. Noise level surveys were conducted in one canning plant, two cotton gins, and three sugar mills. It was found that for all plants average work station noise levels exceeded OSHA's standard, and that workers should be limited to 4-5 hour exposures without hearing protection. Engineering measures are being taken to reduce noise levels.

Sponsor: Cooperative State Research Service
Investigator: D. L. Roberts, Louisiana State University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	4.3*	3.4*		

Human Factors Engineering

The objective of this study is to evaluate agriculture worker's performance, safety and comfort as affected by machine vibration, noise, dust, temperature, and other environmental factors. As part of this project the hearing of full time farmers in Michigan exposed to tractor noise, combine noise, etc. was tested. Farmers were asked to come in voluntarily and were counseled to wear hearing protectors if they showed hearing loss.

Sponsor: Cooperative State Research Service
Investigators: R. H. Wilkinson, Michigan State University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		2.2*		

DOMESTIC ANIMALS AND WILDLIFE

Effect of Environmental Stresses on Large Animals

The purpose of this study is to determine physiological responses of domestic animals to various environmental stresses. The effects of heat, cold, and noise are being examined. Domestic animals (sheep, cattle) have been exposed to different types and intensities of noise to determine changes in metabolic rate, reproduction, eating habits and the animals acclimation to noise.

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* For noise effects only

Sponsor: Cooperative State Research Service
Investigators: D. L. Ames, Kansas State University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	3.3	2.9		

The Effect of Noise Pollution on the Fowl

The objectives of this study are to determine the hearing range of chickens, record and analyze hawk sounds, and determine effects of hawk's frequencies on chickens. Electroencephlograms are obtained during noise exposures, and damage to the ear is examined.

Sponsor: Cooperative State Research Service
Investigators: M. A. Boore et al., Clemson University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	2	Completed		

Low Frequency Sound used to Control Stored-Product Insects

Insects will be exposed to various sound frequencies and intensities to determine if sound will shorten or lengthen life cycles reduce fecundity, or influence dispersal of fumigants or inert gases in bulk commodities. This approach will be tested as a part of an integrated control approach with other physical and chemical control practices.

Sponsor: Agricultural Research Service, Georgia-South
Investigators: M. A. Mullen, USDA Stored Products Insects R&D Lab

Fiscal Year Funding ($1000)	1975	1976	1977	1978
		50	Completed	

Poultry Production and Environmental Quality

The noise related portions of this project included characterization of noise levels within poultry houses and a study examining the effects of ultrasound on egg production.

Sponsor: Cooperative State Research Service
Investigator(s): W. O. Wilson, D. Vohra, University of California, Davis

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	.7*	1.5*	2	2

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* For noise effects only

NOISE ENVIRONMENT DETERMINATION

Measurement and Control of Dust Emission and Noise Pollution in Grain Handling Facilities

To meet health and safety needs of plant workers noise levels are being determined for grain handling and conditioning machinery, and control methods are being studied.

Sponsor: Agriculture Research Service, Kansas-Nebraska Area.
Investigators: G. H. Foster, C. R. Martin, in-house

Fiscal Year Funding ($1000)	1975	1976	1977	1978
		40	Completed	

NATIONAL BUREAU OF STANDARDS

NBS performs research for several government agencies. These projects are reported both under sponsoring agency and NBS.

NOISE INDUCED HEARING LOSS

Hearing Measurements for Standardization

The objectives of this study are as follows:

- to maintain and disseminate standards for normal threshold of hearing;
- to develop new data on normal hearing, particularly on auditory resolution capabilities and loudness perception;
- to develop supratheshold tests for auditory perception yielding diagnostic data for distinguishing noise trauma from ordinary presbycusis and other hearing dysfunctions.

To accomplish these aims the following work was planned for 1977.

Measurement of growth of tonal recognition vs. signal duration on a group of normal subjects, comparison of loudness growth as a function of duration for pure and complex tones, measurement of resolution of time-varying test tones as a function of duration and level, and extension, dissemination, and transfer of normal hearing data for audiometry.

Investigator: E. Corliss, NBS

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
		121	70	90 (in-house)

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Highway Noise Criteria

The goals of this project are to:

- identify and quantify important physical parameters affecting human response to time-varying traffic noise, associated with varying densities of free-flowing highway traffic and stop-and-go urban traffic;
- investigate and compare various measures and compurtational procedures for rating time-varying traffic noise and determine which method, or methods, best predict the subjective response of people to the noise of various types of traffic situations;
- develop, if necessary, improved procedures for rating time-varying traffic noise in terms of measurable parameters of traffic noise;
- formulate procedures by which the most useful of the above rating procedures may be related to the environmental noise descriptors

and criteria developed by the EPA, if the most useful procedures are found to be different from those recommended by the EPA.

Sponsor: DOT

Investigators: S. Yaniv, D. Flynn, NBS

Fiscal Year Funding ($1000) :

1975	1976	1977	1978
	100	100	100

Transmission Line Audible Noise Measurements

The objectives of the study are: to investigate measurement scales for audible noise generated by high voltage transmission lines, to relate these scales to human response, to determine the adequacy of present scales and units; to compare transmission line audible noise with other environmental noises; to determine whether the high frequency or low frequency components contribute most to human aversion. The research involves tape recording the audible noise generated by extra-high voltage (EHV) and ultra-high voltage (UHV) transmission lines. Individual subjects listen to these noise stimuli in a simulated living room for about 15 one-hour sessions while their responses are observed. Four of these experiments will be done.

Sponsor: ERDA

Investigators: J. Molino, Zereley, Lerner, Harwood, NBS

Fiscal Year Funding ($1000) :

1975	1976	TQ	1977	1978
	93	43	143	143

Noise In and Around Buildings

This program, which was initiated in 1974, is directed towards a better understanding of human response to noise in buildings. Government agencies such as EPA, HUD, and DOT and attitude surveys have indicated that noise, particularly impact noise, may cause considerable annoyance in residences. The approach is to obtain physical and human response measurements of sounds and correlate these findings. At present a laboratory investigation to assess rating schemes for predicting loudness response to noise from household appliances is being completed. NBS is also participating in several standards working groups.

Investigator : S. Yaniv , NBS

Fiscal Year Funding ($1000) :

1975	1976	1977	1978
60	60	65	70 (in-house)

Human Response to Noise

The objectives of this project are to reduce discrepancies between estimates of response to environmental noises based upon physical measurements and standardized rating scales and the actual responses of human beings to sound exposures, and to produce criteria for more accurate noise rating scales and sound-measuring equipment. Work planned for 1977 includes the following activities:

- Improved "acoustic menu" techniques for measuring differences in aversion reactions, without verbal descriptors;
- Testing and automation of a new "living-room" laboratory for subjective measurements under realistic conditions;
- Study of time-intensity (duty cycle) relationships to aversion perception. Scaling of verbal descriptors elicited from subjects on a scale of emotional reactions.

Investigator: J. Molino, Zerdy, Corner, Harwood, NBS

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	142	124	68	65
				(in-house)

COMMUNICATION INTERFERENCE

Technical Bases for Noise Criteria in Building Regulations

Existing criteria that could be applied to rating the noise environment in dwellings, isolation between dwellings, and from outside-to-inside a dwelling were reviewed. It was concluded that the central problem is to select appropriate criteria for rating the interior noise environment. Once this is done, criteria for noise isolation can be derived directly. These criteria can be used to derive performance requirements for building elements, such as partitions and exterior walls.

Sponsor: EPA/ONAC

Investigators: S.L. Yaniv and D.R. Flynn, NBS

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	25	Completed		

NOISE ENVIRONMENT DETERMINATION

Noise Impact from Consumer Products and Household Appliances (Conceptual Model)

This is an investigation of the noise impact of household and consumer products on people. Its objectives are the development of a model for assessing the impact of noise from household and consumer products on the health nad welfare of the national population, and a demonstration of the application of this model to specific classes of products. Available and published data are being collected from the literature with respect to noise emission characteristics, usage patterns and installation/operation conditions. Gaps in available data will be identified and procedures for collection of additional data will be recommended. A classification scheme (such as the consumer product safety index) will be developed for these products, and a step-by-step procedure for assessing health and welfare effects will be developed. This procedure will be applied to one appliance to illustrate its use in assessing the noise impact of such products and in evaluating the benefit to be gained from regulation of such products. This project should be completed in 1977.

Sponsor: EPA/ONAC

Investigators: S.L. Yaniv and D.R. Flynn, NBS

Fiscal Year Funding ($1000) :	1975	1976	1977	
			45	Completed

Sound Pressure Distribution Around Manikin Head and Torso

The transformation of a diffuse sound pressure field to a manikin's ear, head surface, and torso surface was measured in a 425 m^3 reverberation chamber between 0.2 and 10.0 kHz using 1/3 octave bandwidth random white noise. The maximum gain in sound pressure level at the microphone in an earlike coupler relative to the diffuse-field pressure was measured to be 15 dB at 2.7 kHz. Further measurements show that the pressure level buildup at the manikin's head surface and torso surface, when bare (acoustically hard), ranges from 0 dB at low frequencies to +4 dB at high frequencies. Absorptive clothing reduces the pressure level buildup on the torso, where body-worn hearing aids or dosimeters may be located, to values ranging between -1/2 dB to +1 dB for frequencies 1.6 kHz. Theoretical predictions of the diffuse field gain at the "eardrum" and head surface compare well with the experimental data.

Sponsor: NBS

Investigator: G. Kuhn, NBS

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
		30	55	22 (in-house)

CONSUMER PRODUCT SAFETY COMMISSION

NON-AUDITORY HEALTH EFFECTS AND PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Analysis of the Non-Auditory Bromedical and Behavioral Effects of Acoustic Noise

In the establishment of standards governing the acceptable levels of acoustic noise associated with consumer products, attention must be given to the non-auditory effects, as well as the auditory effects, of such noise. Before standards based on non-auditory effects can be developed, a better understanding is required of precisely what the effects are, how important they are for the health and safety of the product user, and the variability of people in terms of their non-auditory reactions to acoustic noise. This one year study involves a comprehensive and critical review of the literature addressing non-auditory effects of noise on biomedical and behavioral factors, and a classification of the identified effects in terms of type and magnitude. The ouputs of the study will include a complete analysis of existing and relevant research and identification of requirements for additional research.

Investigator: Ray B. Webster, Systems Research Co., Pa.

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
			36	Completed	

DEPARTMENT OF DEFENSE

AIR FORCE

NOISE-INDUCED HEARING LOSS

USAF Hearing Conservation Program
(Formerly listed as two separate projects - Assessment of Hearing in Flying Personnel, and the Effects of Noise on Hearing Acuity and Functional Ability of Flying Personnel in Air Force Operational Environment.)

Loss of highly trained flying and maintenance personnel due to noise and compensation for hearing loss continue to be major Air Force problems. The primary objective of this effort is to monitor the USAF Hearing Conservation Program, specifically as defined in AFR 161-35, 'Hazardous Noise Exposure' 29 July 1973. The prevention of noise induced hearing loss among AF members, both military and civilian, requires that these personnel be included in a comprehensive hearing program and the purpose of this research is to guarantee that the multifarious elements of this program are effective. In addition, research will be performed to validate auditory risk limits, determine the effectiveness of personal ear protection devices and noise control measures, and insure adequacy of criteria and procedures for disposition of noise-exposed personnel who demonstrate shifts in hearing.

Investigator: D. C. Gasaway, H. C. Sutherland
School of Aerospace Medicine, Brooks AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	41.7	292.7		359	289

Auditory Responses to Acoustic Energy Experienced in Air Force Activities

The objectives of this work unit were to determine personnel exposures in the wide variety of usual and unusual acoustic environs of Air Force operations, and to control, within acceptable limits, the intrusion of Air Force noise into residential areas neighboring Air Force facilities.

Field and laboratory efforts investigated noise-induced hearing loss, personal sound protective devices, speech interference effects, infrasonic and impulsive signals and subjective reaction to noise. In addition procedures for estimating reactions of individuals and communities to noise exposure were also pursued. These findings support criteria and guidelines for risk to hearing, adequate voice communication, effective hearing protection, annoyance and operating procedures which minimize adverse effects.

Investigator: D. L. Johnson, Aerospace Medical Research Lab (AMRL), Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
	122	122	23	Completed

Environmental Noise Research

Research is being conducted on selected contemporary bioenvironmental noise problems impacting on USAF operations and functions. These studies include the evaluation of electrically aided voice communications effectiveness in various AF noise environments, the determination of human auditory response to short duration acoustic stimuli and definition of typical 24 hour exposures of selected populations in terms of A-weighted equivalent sound level. Results of these studies support the laboratory's program to determine auditory effects of various AF noises on personnel, to establish exposure criteria, to evaluate and develop personal protective devices and to incorporate these principles and data into guidelines, specifications and regulations to control noise exposure within acceptable levels.

Sponsors: Air Force and EPA/ONAC

Investigator: W. J. Hovey, University of Dayton

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	10 (AF)	14 (AF)	6	14 (AF)	6
	10 (EPA)	10 (EPA)		10 (EPA)	

Research on Permanent and Temporary Shifts in Hearing Threshold Produced by Exposure to Air Force Noise

There is a need to study the response of the nervous system to the stresses that are expected to occur in aerospace environments in order to determine the fundamental principles for establishing protective devices and techniques to insure safety and unimpaired performance of the nervous system.

Chinchillas will be trained to produce behavioral audiograms prior to exposure to sound environments similar to those expected in Air Force operational conditions. The results of these behavioral methods will be compared with anatomical changes using scanning electron microscope techniques. Human subjects will be used to define the level of long-term exposure that produces changes in auditory acuity. The environmental conditions for human experiments will be chosen only after results from animal studies.

Investigators: D. J. Lim, W. Melnick
Ohio State University

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	
	17	15	4	9.3	Completed

Auditory Effects of Noise Exposure Levels Equal to Hearing Levels

This project is specifically designed to test the assumption in the Levels Document that "one cannot be damaged by sounds which one cannot hear," an assumption that has not been verified. Subjects will have hearing levels of 70 to 80 dB at 4 K Hz, and they will be exposed to pure tones and/or narrow bands of noise at L_{eq}'s of approximately 70 to 80 dB. If no TTS is produced, that evidence will support the Levels Document's assumption. If TTS does occur, then the assumption should probably be removed when the Levels Document is revised.

AIR FORCE (Continued)

Sponsor: EPA/ONAC

Investigator: AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977
			4K (EPA)

Loudness Balance Method of Evaluating Hearing Protectors

The hearing protection features of helmets, headsets and hearing protectors are currently evaluated using standard methods that employ very low level signals. Evaluation procedures that use high level test signals may provide more valid estimates of protector performance in intense noise fields. The objective of this work unit is to assess the validity and accuracy of a suprathreshold loudness balance method of evaluating hearing protectors.

Investigators: M. Stephenson, C. Nixon
AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			17	6 (est.) In-house

Implementation of ANSI Specification S3.19-1974 Personal Hearing Protective Devices for Use in Noise Environments:

Requirements necessary to implement the new standard will be identified, including specification of the instrumentation needed to generate the test signals and record the subjects' responses. A survey will be made of existing facilities to determine whether modifications of these facilities will be required, as well as to determine possible requirements to procure additional instrumentation. When the necessary equipment is available it will be assembled into an instrument console adjacent to the test laboratory to initiate hearing protector evaluations using the ANSI S3.19-1974 standard. Software will be developed to present the data in forms consistent with current methods and standards.

Investigators: M. Stephenson, R. McKinley
AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			8	10.8 (est.) In-house

Evaluation of Hearing Protectors Using ANSI REAT Method

Human subjects were employed in the laboratory evaluation of a hearing protector's sound attenuation characteristics as measured by the American National Standard Institute (ANSI) Real Ear Attenuation at Threshold (REAT) method. Results of these evaluations will be used to formulate recommendations to the office of the AF Surgeon General concerning potential application for AF use. Data will be processed and prepared in formats consistent with general methods used by the scientific community as well as the AF for estimation of noise reduction in operational situations. This effort assures that our data base is current by evaluation of the many modified and new devices appearing on the commercial market in increasing numbers.

Investigators: M. Stephenson, R. McKinley
AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			13	24 (est.) In-house

Effects of Long-Duration Noise Exposure on Human Auditory Processes *

The approach will be to measure safe temporary hearing losses induced in human subjects by long duration low level acoustic exposures and to analyze the hearing recovery curves as additional indicators of risk. Human subjects will be exposed to broadband noise with exposure durations of between 24 and 48 hours. Groups of subjects will experience systematic variations of such acoustic parameters as the intensity, duration, and duty cycle of the test stimulus. Effects of the stimuli will be identified by monitoring the subjects' audiometric thresholds at specific time intervals.

Sponsor: Air Force and EPA/ONAC

Investigators: M. Stephenson, D. Johnson
AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			17	30.6 (est.) In-house

Longitudinal Study of Human Hearing (Children) *

An ongoing longitudinal study of the development and health history of over 400 subjects from the ages of 2 years to 25 years is available. The hearing threshold level of this select population will be obtained and will be correlated with developmental factors, health history, and a noise exposure questionnaire.

Sponsors: Air Force and EPA/ONAC

Investigator: A. F. Roche, Samuel S. Fels Institute, OH

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
		4	1	3	44

Human Subjects for Operational Acoustic Research

This is a continuing effort which is vital to the accomplishments of in-house bioacoustic research . During this reporting period subjects have been furnished on a continuing and timely basis for studies involving hearing protector evaluations, speech intelligibility evaluations for some new light weight helmet designs, for a counting task conducted during noise exposure to infrasound and for an extensive investigation of speech reception in noise on persons with normal hearing and mild hearing loss.

*Jointly funded project. Only AMRL funding is given here.

AIR FORCE (Continued)

Investigator: W. Hovey

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978	1979
	3.5(AF) 20(EPA)	3.5	10	36	36	5.4

Hearing Risk Due to Communication Signals

Effective voice communication in high level noise environs may require air and ground crew personnel to increase the intensity of the signal to a level that is damaging to hearing. The objective of this effort is to measure ambient noise and voice communication signal levels under standard AF communication devices during a variety of air and ground operations to quantify the hearing damage risk and to consider alternate operating procedures that eliminate such risk. This effort will benefit the SG, ASD Life Support SPO, base bioenvironmental engineers, as well as air and gound crew effectiveness and safety.

Agency: Air Force, AMRL

Investigators: McKinley, R.L.

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979
			7	7	2.5 (est.) In-house

Changes in the Organ of Hearing Produced by Sound *

The purpose of this work unit is to examine changes in the auditory system produced by exposure to excessive sound. The effort will emphasize studies in the infrasound (1-20 Hz) region and long-term, low-level exposures at mid-frequencies (600-2000 Hz). Goal of the research is a reasonable hypothesis of the mechanism of injury production that provides a rationale for treatment and prevention. Results of this basic research are used in the AMRL applied technology program in establishing guidelines for limits of exposure and methods of protection from exposure to excessive sound. Ultimately this forms the basis for Air Force regulations governing exposure and protection criteria. Data are also used by the Environmental Protection Agency.

Infrasound exposures will be carried out only on experimental animals. Long-term, low-level exposures will be carried out on experimental animals and human volunteer subjects at levels which do not produce permanent changes in hearing. Techniques to be employed include light and electron microscopy of inner ear structures, electro-physiological measures of middle ear muscle activity and psychoacoustic measures of changes in auditory acuity.

Sponsors: Air Force and EPA/ONAC

Investigators: D. Lim and W. Melnick
Ohio State University

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979	1980
			15	18	18	8

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* Jointly funded project. Only AMRL funding is given here.

NON-AUDITORY HEALTH EFFECTS

The Whole-Body Effects of Air Force Noise on People

A wide range of intense Air Force noise environments not only affect hearing but may interfere with motor performance, physiological functioning, though processes and contribute to fatigue in personnel. This effort, which was completed at the end on 1976, investigated types of noises and exposure conditions which may produce adverse whole body effects that interfere with accomplishments of the AF mission.

The approach used was to measure effects of the many kinds of noises (infrasound, audio frequencies, impulses) on a battery of standard performance tasks, on circulation in the peripheral members (fingers) and other physiological processes and on mental tasks such as memory. Findings are being used to establish exposure limits beyond which undesirable effects may occur. The projects entitled "Acoustical Degradation of Human Capabilities" and "Human Capabilities in Infra-Sound" are follow ons to the work done in this study.

Investigators: C.S. Harris, C.W. Nixon, AMRL Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	54.5	54.5			Completed

Human Capabilities in Infra-Sound

Various AF noise environments contain high intensity acoustic energy, in the frequency range below approximately 16 Hz (infrasound). Although this very low frequency energy has little effect on hearing it may adversely influence physiological functioning, psychomotor and cognitive performance. The objective of this research is to systematically investigate the effects of infrasound exposures on the capabilities of human subjects to perform selected tasks. The threshold of these effects, the nature and extent of the interference and the overall performance limits will be defined in terms of the acoustic exposures. This effort will provide support for the whole body exposure effects standards sections in AFR 161-35. The estimated completion date for this study is the end of 1978.

Investigator: D. Johnson, C. Harris, AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			8	9 (est.) In-house

Attenuation Characteristics of the Womb

It is evident that before a long-term research program on the fetal effects of noise can be initiated, more information on how much sound the fetus actually receives is needed. In order to obtain this information AMRL proposed to measure the attenuating properties of the womb in one to three fairly large mammals.

The task will consist of a literature search, the development of instrumentation and the measurements. Completion is expected around October 1977.

Sponsor: EPA/ONAC

AIR FORCE (Continued)

Investigator: R. McKinley, AMRL Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
				5 (EPA)

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Acoustical Degradation of Human Capabilities

Air Force noise environments may affect motor performance, physiological function, thought processes and contribute to fatigue in personnel as well as affecting hearing. This effort investigates the types of noise and exposure conditions which contribute to decrements in cognitive and psychomotor capabilities.

The approach is to measure the effects on human performance on a battery of standard tasks such as visual search, tracking, and memory of acoustic stimuli that vary in degreee of predictability. The degree of predictability of interupted continuous and of impulsive noises will be determined by the randomly varying on and off times of the stimuli. Persistency effects will be assessed by measurements taken at various periods following cessation of the acoustic exposure patterns. Findings are to be used to define the acoustical characteristic of Air Force operational environments that contribute to degradation of human capabilities.

Investigator: C. Harris, C. Nixon, AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
				10	10 (est.) In-house

Whole Body Effects of Noise on People

(See Listing Under Non-Auditory Health Effects.)

Auditory Responses to Acoustic Energy Experienced in Air Force Activities

(See Listing Under Noise-Induced Hearing Loss.)

COMMUNICATIONS INTERFERENCE

Communication Interference System

Future requirements of AFR 161-35 and more powerful propulsion systems of current and future aircraft call for research and evaluation of many different communication systems and devices. The objective of this effort is to develop and implement a research and testing system to simulate an operational communication environment and to develop standard research and testing procedures, and data reduction software for evaluation of AF voice communication systems and devices. This effort will support ASD Life Support SPO's and Weapons Systems Development SPO's. This project should be completed in 1978.

Investigator: R. McKinley, M. Skelton , AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
				15	8.5 (est.) In-house

Performance Limits of Ear Insert Communications

Air and ground crew voice communications are degraded by high level environments that exceed the performance limits of present standard communication equipment,creating command and control problems and safety hazards in routine as well as emergency situations. The objective of this effort is to establish the communication and protection performance limits in high intensity noise environments of the ear insert communications concept. This effort will benefit ASD Life Support SPO and ground crew effectiveness and safety by identifying noise exposure envelopes within which the ear insert communications concept will provide adequate hearing protection and satisfactory voice communication.

The approach incorporates the laboratory simulation of specific aircraft noise environs, the progressive evaluation of ear insert units at increasingly intense levels of these environs by measurement of hearing protection characteristics and then communication effectiveness. A hearing protection/voice communication envelope of the performance limits will be developed based on these data for both monaural and binaural cofigurations of the Ear Insert Receiver and compared to the performance of current standard items. This effort should be completed in late 1977.

Investigator: R.L. McKinley, M.R. Stephenson, AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
				10	3.5 (est.) In-house

Auditory Nervous System Performance Changes

The objective of this work unit is to investigate how the information processing capabilities of the auditory nervous system may be altered by exposure to moderately intense acoustic stimuli. This question has been extensively studied under the general headings of "auditory fatigue" and "temporary threshold shifts". Research in the area has concentrated on behavioral changes in signal detection thresholds and morphological and biochemical changes within the inner ear. There is some evidence that there are retrocochlear components to this functional change in the performance of the auditory system (Salvi, R., et al, Sci,. 31 Oct. 75, 486-487, Saunders, J. and Rhyne, R.L., Br. Res., 24, 1970, 339-342, Starr, A., J. Neurophysiol., 28, 1965, 850-862). The elucidation of the mechanisms involved in this phenomenon will provide basic information that will aid in the development of devices and criteria to protect Air Force personnel exposed to noisy environments.

AIR FORCE (Continued)

Investigator: T. Moore

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
				15	9.5 (est.) In-house

Auditory Responses to Acoustic Energy Experienced in Air Force Activities

(See Listing Under Noise-Induced Hearing Loss)

Environmental Noise Research

(See Listing Under Noise-Induced Hearing Loss)

COMMUNITY OR COLLECTIVE RESPONSE

Development of Guidelines for the Assessment of Large Impulsive Noises (Community Annoyance Due to Mining and Quarrying)

The problem of an appropriate methodology for characterizing noise from large impulses and blasting (due to mining and quarrying operations), was raised as part of the CHABA EIS guidelines exercise. The sonic boom methodology described in the EPA Levels Document to apply to blast noise and certain CHABA WG members disagreed. By July 1975 the CHABA WG had agreed on this methodology weighting with a nighttime penalty: "L_{cdn}." This rating scheme has been recommended to the Bureau of Mines.

FY 77 and 78 funds will be used for validation of L_{cdn}. Through AMRL, EPA is trying to assure that there is a coordinated approach to the problem and that everybody (Bureau of Mines, Army) uses the same measurement methodology.

Sponsor: EPA/ONAC

Investigator: AMRL, Wright Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
				5(EPA)	

Guidelines for Environmental Impact Statements on Noise*

The objective of this study is to develop, in conjunction with the National Academy of Sciences/National Research Council Committee on Hearing, Bioacoustics and Biomechanics, guidelines for evaluating the effects of all types of environmental noise on the general population. When these guidelines are finished, they will be validated in order to show that they are correct and reasonable with respect to Air Force facilities as well as specifications, standards, and regulations on noise exposure.

Investigator: H. Von Gierke, D. Johnson, AMRL, Wright Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			13.5	Completed

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* Jointly funded project only AMRL funding given here.

NOISE ENVIRONMENT DETERMINATION

Bioenvironmental Noise Research Program

The high-level noise environments generated by many Air Force weapon systems and equipment are a physical hazard to air and ground crew personnel who must function in these environments to assure mission success, and pollute the environment in areas adjacent to ground and flight operations. The magnitude and character of these physical environments and their bioacoustic effects on man must be known to evaluate environmental impact and resolve such operational problems. The objective of this contract is to provide technical procedures, data and software required to define these noise environments and determine the effects on man and provide such information to Air Force bioenvironmental engineers, medical personnel, civil engineers, base commanders and others concerned with these problems.

Investigator: W. Hovey, University of Dayton

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	65	64		76	75

Noise Dosimetry and Typical Noise Doses*

Various personal noise dosimeters are available on the commercial market. However no systematic study of their merit and shortcoming has been accomplished. At the present time the AF does not use noise dosimetry to assess personal noise exposure. It is essential to evaluate this technical concept to determine if it has a place in the AF hearing conservation program. The objectives are, to evaluate the application of personal noise dosimetry in Air Force environments, to determine the typical noise exposure of Air Force personnel in order to define typical occupational and non-occupational noise exposures, and to assess typical noise exposures relative to allowable exposures specified in AFR 161-35. This work will be coordinated with the USAF Surgeon General and with base level bioenvironmental engineers as well as the US EPA.

Investigator: D. Johnson, R. McKinley, Wright Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			7	6 In-house

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*Jointly funded project. Only AMRL funding is given here.

AIR FORCE (Continued)

Technology Application to Operational Noise Problems

The objective of the work unit is to provide consultation and technical assistant services on acoustical problems related to AF base activities. Laboratory and/or field evaluations are conducted on specific problems or items of equipment to define the threat potential to health and performance capability. Individual efforts are usually short term and include technical questions relating to sonic boom, noise exposure limits, ultrasound, infrasound, impulsive noise, communication equipment and hearing protection. Specific efforts include problems such as flight helmets effectiveness, communication with a fire fighters helmet and with a new oxygen mask microphone in noise. Requests originate from all levels of AF and other governmental agencies and specifically include base flight surgeons, bioenvironmental engineers, systems development offices and the Life Support SPO.

Investigators: C. Nixon, M. Stephenson, AMRL

Fiscal Year Funding ($1000):	1975	1976	1977	1978	
			22	95 (est.)	In-House

NOISE CONCOMITANT WITH VIBRATION

Research on Response of Vestibular System to Acoustic Stimuli

This research will better define the dynamic response of the vestibular system to acoustic stimulation, in terms of intensity level, acoustic frequency (Hz), and intermittency rate of the stimulus. Thresholds will be determined for nystagmic and counter-rolling eye movements, and postural adjustments. A study of the nature and mechanisms of the transfer of acoustic energy to the vestibular system will be made by studying stapes displacement and perilymph and endolymph pressure changes. (Results will contribute toward the development of threshold criteria for hazardous exposure to high-intensity sounds.)

Investigator: D.E. Parker, Miami University

Fiscal Year Funding ($1000):	1975	1967	1977	1978
	10	10	15	15

Simultaneous Exposure to Acoustic Energy and Other Stressors Found In Air Force Environments

This effort investigated physiological and psychological responses of humans exposed to acoustic energy occurring in combination with other stressful stimuli, in order to provide measures for minimizing adverse effects of simultaneous exposure to multiple stresses in Air Force activities.

The approach combined controlled acoustic exposure with mechanical whole body vibration of volunteers to determine effects of the combined exposures on psychomotor task performance, mental or cognitive performance, temporary threshold shift and possible subjective judgments of acceptability. Single stress effects were compared to the measured multiple stress effects to determine differential contributions of the respective stress conditions. Follow-up work to this study is being performed in the project entitled "Combined Noise and Vibration Effects on Human Capabilities."

Investigators: C.S. Harris, AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):

1975	1976	1977	1978
12.5	12.5		Completed

Combined Noise and Vibration Effects on Human Capabilities

Individual and combined effects of whole body vibration and broadband noise will be studied. Single and combined affects will be determined on subjective ratings, cognitive performance, and psychomotor performance. Emphasis will be placed on the use of random vibration stimuli which has not been previously investigated and on longer duration exposures to determine if performance does deteriorate with increasing exposure time. These performance profiles will be developed using the AMRL/BB Acoustic-Vibration facility.

Investigators: C. Harris, R. Schoenberger, AMRL

Fiscal Year Funding ($1000):

1975	1976	1977	1978
		10	12.5 (est.) In-house

NOISE-INDUCED HEARING LOSS

Auditory Performance Changes as a Function of Army Material Noise Exposure

Human performance in detecting targets in combat, in communications tasks and in a variety of other situations, depends upon the ear as a prime source of information input, yet many noise sources act to degrade this input. This program is directed toward determining what acoustic factors produce changes in the ability to detect transient sounds and the physiological basis for changes in performance. The human auditory system will be modeled by animal ears. They will be exposed to impulsive, intermittent and continuous noises and changes in electrophysiological, histological and behavioral measures will be made of the state of the ear and its ability to detect sounds. Data will be analyzed to provide information on both the mechanisms of loss as well as its functional implications in the Army context. Attempts will also be made to improve the accuracy of the modeling by comparison of human and animal ears on the performance measures.

Investigator: G.R. Price, Human Engineering Labs, Aberdeen Proving Ground, Md.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		122	100	135

Hearing Conservation--Intense Acoustic Stimulation and Noise Susceptibility in the Military Environment

The purpose of this research is to study premature hearing loss by U.S. Army troops. This research objective is critical to the needs to the U.S. Army. The study will evaluate current noise hazards, effectiveness of hearing protection devices and current hearing conservation practices in the field.

Investigators: M. Loeb and E. Alluisi, University of Louisville

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		42.5		

Hearing Performance Requirements of Army Personnel

The objectives of this program are to develop predictive models of noise effects on soldiers' performance: (A) To improve existing noise criteria including effects of long-term exposure. (B) To optimize methods for assessing human auditory capabilities. (C) To provide consulative assistance to DOD, national and international acoustical advisory groups.

During FY 75 experiments were continued to establish combat sound detection thresholds for subjects having varying degrees of hearing acuity. The results of these experiments will be used to design future studies having more realistic listening conditions. If possible, a library of tape-recorded sounds will be compiled for use in future experiments.

Investigator: D.C. Hodge, Human Engineering Lab, Aberdeen Proving Ground, Md.

Fiscal Year Funding ($1000):

1975	1976	1977	1978
	122	100	136

Research of Psychoacoustial Problems Medically Significant to Army Aviation

The purpose of this program is to provide information about sound which has medical import to U.S. Army aviation. This program has two basic components. One entails physical description of the critical sound stimuli found in U.S. Army aviation. The second approach involves the effects of these sounds on human receivers. (Note: In FY 77, The Army began reporting research activities and funding under this program by work units, which are included in the Army project descriptions and provide more detailed information).

Investigators: R.T. Camp, B. T. Mozo, Aeromedical Research Lab, Ft. Rucker, Ala.

Fiscal Year Funding ($1000):

1975	1976
250	250

Military Applications of Auditory Assessment

Experiments will be initiated to study the speech discrimination capability of auditorily deficient Army aviators in noise environments. Development and standardization of speech discrimination materials will be undertaken to establish a basis for granting "waivers" to Army aviators with hearing losses. In conjunction with studies of high-intensity impulse noise field audiometric testing and assessment of temporary threshold shift will be undertaken. Basic studies of auditory perception will be conducted to provide baseline data for new audiometric procedures.

Investigator: J.H. Patterson, Aeromedical Research Lab., Ft. Rucker, Ala.

Fiscal Year Funding ($1000)

1975	1976	1977	1978
		74	

Medical Assessment of Hearing Protective Devices

There are sounds inherent in the mission of the Army which will destroy the hearing of personnel exposed to them. The Hearing Conservation Program was instituted to protect the hearing of Army personnel and requires the wearing of appropriate hearing protective devices. This research assesses the sound-attenuating characteristics of new devices as to their suitability to meet the needs of the Army and provides a check on the sound-attenuating characteristics of devices already in use to insure the maintenance of necessary standards.

Investigator: W.R. Nelson, Aeromedical Research Laboratory, Ft. Rucker, Ala.

Fiscal Year Funding ($1000):

1975	1976	1977	1978
		110	

ARMY (Continued)

Military Acoustic Hazards: Mechanisms of Hearing Loss

This research explores relationships between the parameters of noise peculiar to the military environment and the psychophysical and physiological behavior of the human auditory system. These data will be used to establish valid damage-risk criteria to insure the adequate protection of personnel and to maintain an effective Hearing Conservation Program. Studies concerned with the adequacy of current damage-risk criteria will be conducted with animal subjects using behavioral audiometery and histology. Damage-risk criteria for impulse noise will be examined in terms of specifying exposures with respect to spectral analysis of the impulses rather than simply in terms of peak pressure level. The effect of exposure to high-intensity low-frequency noise on the threshold of hearing will be determined. The development of new animal models for the assessment of auditory damage resulting from impulse noise will begin.

Investigator: C.K. Burdick, Aeromedical Research Laboratory, Ft. Rucker, Ala.

Fiscal Year Funding($1000):	1975	1976	1977	1978
			105	

Research of Impact and Noise Attenuating Crashworthy Helmet Earcup

The purpose of this work-unit is to design, construct and medically evaluate the impact and noise attenuating properties of a crashworth aviator's helmet earcup.

Twenty hand-made "test-bed earcups" will be fabricated. The cups will be installed in helmets for in-flight evaluation by USAARL flying personnel under all flying conditions. They will be subjected to accepted standardized impact and acoustic protection evaluation techniques (ANSI Z24.22, Z90.1, etc.) to determine their effectiveness in known physical environments.

Investigator: J.L. Haley, Aeromedical Research Lab., Fort Rucker, Ala.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			34	

COMMUNICATIONS INTERFERENCE

Medically Significant Problems of Voice Communication Systems

The acoustic environments associated with military training and operations in Army helicopters and tanks are usually hazardous and may cause interference with effective voice communications and the detection of warning signals. Most of the present aviation communication systems have characteristics that introduce both frequency and amplitude distortion of the speech signals. This research will be directed toward the development of an improved noise-cancelling microphone for Army aircraft. Improved radio communication systems will be developed for Army aircraft and armor vehicles (e.g., MICV). New communication devices such as contact microphones will be evaluated for their potential use in Army systems.

Investigator: R.T. Camp, Aeromedical Research Lab., Ft. Rucker, Ala.

Fiscal Year Funding ($1000):	1975	1976	1977
			82

Military Applications of Auditory Assessment

(See listing under Noise-Induced Hearing Loss)

COMMUNITY OR COLLECTIVE RESPONSE

Prediction and Reduction of the Noise Impact Within and Adjacent to Army Facilities

In conjunction with other agencies such as the Environmental Protection Agency, models to predict the composite noise impact of Army facilities resulting from the four source types: blast, helicopter, vehicle, fixed, will each be created and tested both for physical and psychoacoustical accuracy. The predictions will use common units and will form "equal noisiness" contours which can be overlayed upon land use maps to graphically expose imcompatible zones. Based upon the predictions,operational and physcial means to reduce the noise impact will be considered and evaluated for cost, effect upon Army operations, and effectiveness in noise mitigation.

As part of this study psycho-acoustical testing with respect to blast noise and rotary wing aircraft, and community surveys to assess the community response to its acoustical environment are being done.

Investigator: P.D. Schomer, Construction Engineering Research Lab.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	*95	*140	*115	*95

NOISE ENVIRONMENT DETERMINATION

Acoustic Environment of Army Prototype Equipment

The development of new Army vehicles, aircraft, weapons and other materiel creates new potentially hazardous noise sources which can adversely affect the health, welfare and operational capabilities of Army personnel. The principal technical objective of this project is to quantify the acoustic environments associated with new Army material in order to assess the hearing damage potential and to support the material developers to produce less hazardous material. The results of this project will have wide application through the Army in support of Hearing Conservation, reducing the incidence of noise-induced hearing loss and providing basic data for research on hearing damage-risk criteria.

Investigator: B.T. Mozo, Aeromedical Research Lab, Ft. Rucker, Ala.

Fiscal Year Funding ($1000):	1975	1975	1977	1978
			105	

Research of Psychoacoustical Problems Medically Significant to Army Aviation

(See listing under Noise-Induced Hearing Loss)

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*Noise effects only.

NOISE INDUCED HEARING LOSS

Development of Damage Risk Criteria for Continuous Noise Exposures in Hyperbaric Environments

The objective of this study is to determine the effects of increased ambient pressure on the development of noise-induced temporary and permanent auditory threshold shift, and, further, to establish the maximum allowable levels and durations of noise exposure experienced by diving research subjects participating in long-term studies inside pressurized chambers.

Temporary noise-induced shifts in human audiograms will be measured, using modern audiometric techniques in both normal ambient pressures and in the increased ambient pressures of a hyperbaric chamber. The human subjects employed will be divers participating in research projects conducted in the Diving and Hyperbaric Medicine Branch of the Naval Submarine Medical Research Laboratory and approved by the Secretary of the Navy. Permanent shifts in animal audiograms resulting from noise exposure in normal and hyperbaric environments will also be examined, using computer-averaged auditory evoked response (AER) techniques. These data will be employed to determine the applicability of conventional damage risk criteria to hyperbaric situations and to develop hearing conservation standards for long-term hyperbaric investigations.

Investigators: P.G. Lacroix, Naval Submarine Medical Research Lab, Conn.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	14	28	23	

Development of Damage Risk Criteria and Habitability Standards for Exposure to Sonar Transmissions

The objective of this study to to develop hearing conservation standards for submariners exposed to intense tonal stimuli, such as are transmitted to compartments within attack submarines by active sonar systems, to specify performance interference levels for sonar operation and other shipboard tasks and to determine the habitability of ship compartments subjected to prolonged and intense sonar signals.

The approach includes measurement of temporary auditory shifts and other physiological and behavioral changes resulting from controlled exposure to various sonar signal configurations. Effects of extraneous echo-ranging signals on sonar operations detection and classification performance will also be determined.

Investigators: P.F. Smith, Naval Submarine Medical Research Lab, Conn.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	41.8			

Middle Ear Compliance and Its Relationship to Military-Related Noise-Induced Hearing Loss and Acoustic Trauma

The objective of this study was to determine whether there is any degree of increased middle ear compliance in patients with hearing loss secondary to acoustic trauma or excessive prolonged noise exposure. This combination is quite common in the military especially in aviators and supporting personnel. Using the Grayson Stadler oto-admittance meter, middle ear compliance was measured in personnel seen at this hospital having audiograms. The results of audiograms, middle ear compliance and noise exposure history were then correlated to provide data regarding susceptibility to noise-induced hearing loss in military personnel.

Investigators: W. T. Moroika, U. S. Navy Hospital, San Diego, Cal.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	3.7			

Physiological Effects and Mechanism of NAACH Hearing

The purpose of this study was to determine how the NAACH (non-acoustic auditory coupling to the head) audio system, which was designed for high intensity noise environments such as aircraft cockpits, functions, and further to determine whether the high voltages (500-1500 VD-C, 0-3000 VA-C) applied to the head by NAACH systems result in deleterious effects upon the body or in any way alter vital functions.

Action potentials and cochlear microphonics and the decrement in each were recorded in anesthetized experimental animals during separate presentation of airborne, bone-conducted, and NAACH-transmitted sound before and after each step of sequential impairment of the ear. The short- and long-term effects of this system on hearing, equilibrium, orientation, enzyme activities of the brain stem, and other vital functions was also observed.

Investigator: F.H. Jacobson, Navy Crew Systems Department, Pa.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	71	45		

A Study of Anatomic Changes in Middle Ear Associated With Noise-Induced Hearing Loss and Acoustic Trauma

This study correlated anatomic changes with noise-induced hearing loss and acoustic trauma. Histologic examination of temporal bones obtained from autopsies were evaluated for changes in the auditory nerve and organ of Corti. Correlation was made with the background of noise and acoustic trauma as well as with clinical findings, including the audiogram in active duty and retired personnel.

Investigators: M.J. Rensink, T. Acomb, U.S. Navy Hospital, Cal.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	10			

The Prevalance of Hearing Loss Among Various Navy Rated Personnel

The objective of this study is to determine the prevalence of hearing loss among various Navy rated personnel.

Hearing threshold levels and noise history questionnaire data on statistically significant numbers of Navy personnel working in various Navy rated job specialities are being obtained. Average hearing levels for the various specialities will be compared with baseline audiometric threshold data obtained from young adult males entering the Navy and control groups of equivalent time in service.

Investigators: R.M. Robertson, Naval Aerospace Medical
Research Laboratory, FLa.

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	40.8	80	29	102.5	

Development of Auditory Screening and Acoustical Tolerance Standards for Submarine/Shipboard Personnel

The objectives of this research are (1) to validate new audiometic standards for submarine personnel so as to improve intelligibility of speech and signals among personnel in jobs requiring a high level of auditory acuity, (2) to reduce numbers of submarine personnel, otherwise qualified, who may be unnecessarily lost by reason of present auditory standards and (3) to prevent the development of hearing defects among career submarine personnel. As needed, standards will also be validated for surface ships.

The approach includes experimental studies to assess auditory perception of a variety of speech materials and signal stimuli, embedded in various background sound fields, for personnel with differing levels of acuity determined by present standards. Longitudinal studies are being conducted to assess changes in hearing abilities among submarine personnel so as to identify predictive indices of hearing loss and the habituation process which enhances operator auditory acuity; the latter having a potential benefit in the design of training programs, auditory aids, or acoustical characteristics of submarine environment.

Investigator: P.G. Lacroix, Naval Submarine Medical Research Laboratory

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	32	33	24.5	

NON-AUDITORY HEALTH EFFECTS

Sonic Decompression

This study was done to determine the effects of sound on the decompression process for the following cases: (1) Bubble formation in non-living substances; (2) Bubble formation in living tissue; (3) The incidence and onset of decompression sickness in small animals. The results of these tests will be used to determine if sound can be used in a method of decompressing divers from long and/or deep dives and to determine the possible effects of existing sonar on divers or swimmers.

The approach included testing various non-living substances such as water and gelatin under decompression conditions subjected to sound of various frequencies and intensities, and testing small animals such as frogs, mice, and guinea pigs under conditions of some decompression. Bubble formation was observed by various means in living tissue and in post mortem evaluations.

Investigators: J.R. Losee, S. Ridgeway, Undersea Survey & Ocean Science Department, Cal.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	60	34		

Lung Resonance and Acoustic Damage

The objective of this study is to determine to frequency range and sound pressure levels that are most likely to be destructive to lung tissue of Navy divers. Acoustic techniques developed will be employed to radiate submerged laboratory swine. Resonant frequencies will be determined for the lungs of each individual pig. The animals will be exposed to sound at nigh frequency ranges and then, according to lung resonance, to low frequencies. The sacrificed animals will be examined grossly and histopathologically for lung damage.

Investigator: J.C. Sweeney, Naval Undersea Center, Cal.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
		15	17	

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Development of Operational Auditory Performance Standards for Navy

This is a five-year study. The objective of this study is to develop a workable set of psychoacoustic standards based on operational requirements for the human auditory system needed for a broad spectrum of Naval aviation tasks. These standards will be used for screening new personnel and periodic evaluation of existing personnel. The requirements for the auditory system will be derived from a simple operational model of task performance. Inputs to the model will come from: 1) compilation and analyses of operational tasks; 2) description and analyses of operationally relevant auditory sensory inputs and relevant audiotry processing requirements; 3) description and analyses of environmental and psychophysiological factors which influence auditory performance; and 4) laboratory and field experiments with operational personnel to confirm the applicability of the psychoacoustic standards.

Investigator: J.D. Mosko, Naval Aerospace Medical Research Laboratory, Fla.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
			41	60

Airborne Noise Criteria for Ships and Submarines

Airborne noise on naval vessels is a constant threat to operational capability and crew safety. Noise interferes with hearing verbal commands, produces hearing loss of personnel, limits habitability of quarters. Since noise quieting is costly, a constant review of naval missions and shipboard tasks as affected by noise is necessary to set realistic criteria for acceptable noise on ships and submarines.

In this study measurements of airborne noise in various ship interior spaces will be obtained and compared with measures of performance and habitability by observation, questionnaire and lab controlled environmental conditions. The adequacy of measurement procedures under actual shipboard conditions, in lab and field, will be evaluated.

Investigators: R.S. Gales, Navy, Biosystems Research Development, Cal.

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	50	50	12.5	60	50

SLEEP

Personnel Technology: Effects of Combined Pharmacological and Biofeedback Procedures on Performance Enhancement

This work unit was concerned with exploring the effectiveness of combining selected drugs with bio-feedback techniques in teaching people to learn to control bodily responses associated with sleep, relaxation, and alert performance. Noise was introduced to increase the difficulty of going to sleep with anticipation of a demanding task to be performed upon waking. Drug assisted subjects operating under bio-feedback with a self generated conditioned stimulus were compared with controls who were similarly treated but received no drugs.

Investigator: P.M. Hurst, State College, Pa.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	25			

Sleep Patterns and Performance in Operational Environments

Amount of sleep and quality of sleep are concerns in both operational and medical settings. To date, there are little data on the pattern of sleep in various operational units, and what constitutes a sleep problem is unclear. The relation of sleep patterns to performance and the contribution of sleep problems to other medical complaints are often inferred, but quantitative studies are lacking. This research program will survey the sleep patterns in various naval units and commands to obtain baseline data on sleep patterns and number and types of reported sleep problems. The relationship of these sleep data to performance and medical complaints will be investigated. The effects of environmental factors, such as noise, temperature, duty schedules, etc., on sleep patterns and sleep complaints will be studied.

Investigator : P. Naitoh, Naval Health Research Center, San Diego, Cal.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
		77	90	

COMMUNICATION INTERFERENCE

Optimization of Speech Communications in Naval Aviation

The objective of this work was to improve speech communications in various naval aviation acoustical environments.

Tests and procedures were developed for assessing (1) the ability of aircrewmen to transmit and perceive speech in various naval aviation acoustical environments and (2) the capabilities of a wide variety of naval aviation communication systems to transmit intelligible speech and those aspects of the acoustic speech signal which are important for determining both the identity of the talker and his physiological and emotional state. This project was completed in 1975.

Investigators: C. Williams, Naval Aerospace Medical Research Lab, Fla.

Fiscal Year Funding ($1000)	1975	1976	1977	1978
	46.4			

Surveillance: Identification of Psychological Features in the Recognition of Complex, Non-Speech Sounds

Aural sonar displays are not considered competitive with machine-aided visual systems for initial target acquisition, but auditory skills do emerge as rivals in target-tracking modes, in the extraction of tactical information, in the presence of noise interference, and for target classification. A reassessment of the utility of aural displays in those latter functions has become appropriate due to new knowledge about auditory capabilities. This program will identify the parameters of auditory targets that are significant in the classification task and indicate those that recommend themselves for improved sonar systems and ASW procedures of the sonar operator.

Observers judge pairs of complex auditory target signals in terms of "degree of similarity" to each other; and also, they judge single signals in terms of a label or category which has been assigned to a set of similar signals to derive a confusion matrix. The signals vary along four physical dimensions: waveform, frequency, number of formats, and format position. Through multi-dimensional scaling of responses, the psychologically significant features are identified and related to the physical parameters for each observer and for all observers as a group. The role of temporal sequence of auditory signal components is examined in the same manner.

Investigator: J.H. Howard, Catholic University of America

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	34	49	50	

The Effects of Ear Protective Devices on the Auditory Performance of Equipment Operators in High-Level Noise Environments

The objective of the this research is to determine the effects of ear protectors on the ability of human operators to detect and troubleshoot subtle changes in equipment noise. These effects are being examined for operators having normal hearing and for those suffering some degree of hypacusis.

Measures of the ability to detect changes in the acoustic power spectra of various equipment in high-level noise are obtained from normal-hearing and hypacusic persons. Similar measures are then obtained under conditions simulating the wearing of ear protectors.

Investigator: P.F. Smith, Naval Submarine Medical Research Laboratory, Conn.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	14	22	20.4	40

Optimization of Auditory Performance and Speech Communications in Navy Operational Environments

The work performed during 1975 and 1976 was summarized as follows.

Modifications to a new sound powered phone unit (9AN/3SP) being considered for Navy use have been completed by the manufacturer and evaluated in the laboratory plus aboard the U.S.S. Lexington during air operations. The modified units performed better than previous production units and provided adequate noise attenuation (approx. 30 dBA). Addition of a noise enhancer did not improve speech level or clarity. Questionnaire data revealed that, compared to currently used sound powered phones, users could hear transmissions better and outside noises sounded quieter. Production model units (436) have been subjected to quality control checks and have been distributed to carriers for a fleet technical evaluation. Verbal comments and questionnaire responses from flight deck and deck-edge users aboard the U.S.S. Kennedy were positive. Data collection and reduction have been completed in the study of the effect of noise exposure during helicopter flight training on the hearing of naval aviation officer candidates. Two publications. This project has been terminated because of lack of resources.

Investigator: C.E. Williams, Aerospace Medical Research Laboratory, FLa.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	60.5	48		

NOISE ENVIRONMENT DETERMINATION

Personnel Technology: Survey of Occupational Noise Exposure in Selected Spaces . . .on Selected Destroyer Ships

The objective of this work unit was to identify the magnitude of the occupational noise exposure problem, determine the state and extent of noise control technology, and identify related costs, within selected spaces onboard operational destroyer type ships.

Investigator: B.A. Kuglar, Bolt Beranek and Newman, Cal.

Fiscal Year Funding ($1000)	1975	1976	1977
		41	

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Transmission Line Audible Noise Measurements

The objectives of this study are: to investigate measurement scales for audible noise generated by high voltage transmission lines, to relate these scales to human response, to determine the adequacy of present scales and units; to compare transmission line audible noise with other environmental noises; to determine whether the high frequency or low frequency components contribute most to human aversion. The research involves tape recording the audible noise generated by extra-high voltage (EHV) and ultra-high voltage (UHV) transmission lines. Individual subjects listen to these noise stimuli in a simulated living room for about 15 one-hour sessions while their responses are observed. Four of these experiments will be done.

Investigators: J. Molino, Zereley, Lerner, Harwood, NBS

Fiscal Year Funding ($1000) :	1975	1976	TQ	1977	1978
		93	43	143	143

DOMESTIC ANIMALS AND WILDLIFE

The Environmental Effects of Noise from Geothermal Resource Development

Noise is a matter of concern in areas of geothermal resource development, and its effect on faunal toleration and auditory organs is little known. This research evaluated the effects of the noise on selected species of birds and small mammals. The research included five main tasks: (1) measurement of actual noise levels in geothermal areas; (2) laboratory measurements of damage to auditory organs (cochlea of inner ear) by different noise level and exposure times; (3) field study to evaluate voluntary toleration limits of selected fauna to noise; (4) literature and field study to assess the effect of noise of animal communication, hence survival; and (5) field study to measure the effect of noise on species reproduction and population density. This study will provide both physiological and ecological data, two factors which, in addition to esthetic considerations, are needed in order to assess the effect of noise from a geothermal operation. During the first year of the research (NSF/RANN Grant 75-18641) emphasis was on studying noise at The Geysers, California. During the second year, work started at Cerro Prieto, Mexico, and the test facility at Niland, Imperial Valley, California. First-year findings suggest that animal behavior is not affected at sound levels below 65-70 dB, and that level is usually reached at the outer margin of the facility construction area.

Investigator: P. Leitner, St. Marys College of California

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	45	29		

NOISE-INDUCED HEARING LOSS

Early Detection of Noise Induced Hearing Loss

The relationship between TTS and intensity discrimination in normal, noise exposed listeners is being investigated.

Temporary noise-induced shifts in auditory pure-tone thresholds, intensity discrimination (as an analog of loudness recruitment), and critical band-related tone-on-tone masking are being studied. Decay (recovery) functions of these three parameters are being compared and evaluated in terms of their respective potential for detecting early changes in auditory function due to noise exposure.

Sponsor: EPA/ONAC

Investigators: P. Michael, G. Bienvenue, Pennsylvania State University, Acoustics Laboratory

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
		47		20	

Auditory Effects of Long Duration Noise Exposure *

This project will evaluate effects of intermittent noise over periods of 24 hours.

Attempt will be made to validate EPA's identified "no effect" level by exposing subjects to 24 to 48 hour doses of 65, 70, 75, 80 dBA in the laboratory. The dependent variable will be TTS. Although TTS is not the only means of verifying the level, it will provide some insight.

Sponsor: EPA/ONAC and Air Force

Investigator: M. Stephenson, Aerospace Medical Research Laboratory, (AMRL), Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	10	10	10	2

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* Jointly funded project. Only EPA funding is given here.

Longitudinal Study of Hearing Levels in Children *

An ongoing longitudinal study of the development and health history of over 400 subjects from the ages of 2 years to 25 years is available. The hearing threshold level of this select population will be obtained and will be correlated with developmental factors, health history, a noise exposure questionnaire, and limited dosimetry.

The purpose will be to identify the causes of the differences in hearing levels between young men and women, to correlate hearing level of individuals with their medical and developmental histories.

Sponsors: EPA/ONAC and Air Force

Investigators: A. F. Roche, Samuel S. Fels Insittute, OH

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	15	33	30	35

Auditory Effects of Noise Exposure Levels Equal to Hearing Levels

This project is specifically designed to test the assumption in the Levels Document that "one cannot be damaged by sounds which one cannot hear," an assumption that has not been verified. Subjects will have hearing levels of 70 to 80 dB at 4 K Hz, and they will be exposed to pure tones and/or narrow bands of noise at L_{eq}'s of approximately 70 to 80 dB. If no TTS is produced, that evidence will support the Levels Document's assumption. If TTS does occur, then the assumption should probably be removed when the Levels Document is revised.

Sponsor: EPA/ONAC

Investigator: AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			4	

Changes in the Organ of Hearing Produced by Sound *

The purpose of this work unit is to examine changes in the auditory system produced by exposure to excessive sound. The effort will emphasize studies in the intra-sound (1-20 Hz) region and long-term, low-level exposures at mid-frequencies (600-2000 Hz). Goal of the research is a reasonable hypothesis of the mechanism of injury production that provides a rationale for treatment and prevention.

* Jointly funded project. Only EPA funding is given here.

Infrasound exposures will be carried out only on experimental animals. Long-term, low-level exposures will be carried out on experimental animals and human volunteer subjects at levels which do not produce permanent changes in hearing. Techniques to be employed include light and electron microscopy of inner ear structures, electrophysiological measures of middle ear muscle activity and psychoacoustic measures of changes in auditory acuity.

Sponsors: EPA/ONAC and Air Force

Investigators: D. Lim, W. Melnick, Ohio State University

Fiscal Year Funding ($1000):	1975	1976	1977
			8

NON-AUDITORY HEALTH EFFECTS

Attenuation Characteristics of the Womb

It is evident that before a long-term research program on the fetal effects of noise can be initiated, more information on how much sound the fetus actually receives is needed. In order to obtain this information AMRL proposes to measure the attenuating properties of the womb in one to three fairly large mammals.

The task will consist of a literature search, the development of instrumentation and the measurements. Completion is expected around October 1977.

Sponsor: EPA/ONAC

Investigator: R. McKinley, AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			5	10

Protracted Noise Exposure and Cardiovascular Function *

Quantitative criteria for the effects of noise on the cardiovascular system are needed in order to protect the health and welfare of the American Public from adverse effects of noise. Research on the nonauditory physiological effects of noise has been identified as a particularly pressing need. This project will help fill this gap by generating data on the presence (or absence) and degree of significant cardiovascular adjustments as a result of protracted noise exposure.

Preliminary results show that prolonged exposure to moderate noise levels, such as urban traffic noise, caused significant increases in heart rate in a female Rhesus monkey. The heart rate had still failed to return to normal 4 months after the noise had stopped.

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* Jointly funded study. Only EPA funding is given here.

EPA (Continued)

Sponsor: EPA/ONAC and NIEHS

Investigator: E. A. Peterson, University of Miami, Florida

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			58.6	30.2

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Assessment of the Relationship Between Annoyance and Intrusiveness of Noise Sources

The purpose of the proposed program is to investigate and empirically establish the relationship between acoustic intrusiveness and community annoyance. The technical approach proposed is a laboratory investigation to study the concept of scaling annoyance by detectability. The overall objectives of this program are (a) to determine if annoyance is a function of the background noise environment, (b) to ascertain whether signals of equal detectability of intrusiveness are equally annoying, (c) to determine the existence of an orderly relation between annoyance and detectability of intrusiveness and (d) to provide a scaling of the intrusiveness-annoyance relationship. This contract action will enhance EPA's efforts in determining the potential health and welfare benefits/impacts that may result subsequent to various source emission regulatory programs associated with products identified as candidates for regulations or labeling.

Sponsor: EPA/ONAC

Investigator: S. Fidell, Bolt Beranek, and Newman

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			70	

Evaluation of Data on the Subjective Effects of Noise

The objective of the proposed contract is to determine (a) the best methodology or calculation rating scheme for assessing the subjective magnitude of sound, (b) the importance of non-acoustical factors in the assessment of aversiveness of noise, and (c) the best frequency weighting for the assessment of the subjective magnitude of noise. The Contractor shall, under the direction of the Project Officer, assemble and evaluate published and unpublished data on the subjective effects of noise and recommend additional data and research needs which may be required to arrive at the most accurate and precise methodology to assess the health and welfare effects of noise. The effort must be vigorously pursued in order that the required information will be available to EPA/ONAC for the determination of health and welfare benefits associated with ongoing regulatory activities, and prior to the inception of further regulatory activity of products identified as major sources of noise.

Sponsor: EPA/ONAC

Investigator: B. Scharf, Northeastern University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			20	

Review of Literature on Loudness and Annoyance of Impulsive Noise

The study included both subjective and objective aspects of impulsive noise. The subjective aspect, based solely on the available literature, emphasized evaluation of annoyance and loudness from repetitive impulse noise such as from unmuffled two-cycle motorcycles, rock drills, pavement breakers, and industrial garbage compactors. The objective portion of the study included an experimental evaluation of the measurement of a wide variety of simulated repetitive impulsive-type signals varying in duty cycle, repetition rate, pulse frequency, and ratio pulse peak signal level to continuous background noise level.

Sponsor: EPA/ONAC

Investigators: L. C. Sutherland, M. C. Lee, R. E. Burke,
Wyle Laboratories, CA

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		15		

Behavioral Correlates of Varying Noise Environments

Phase I of the studies investigated influence of noise environments on motor skill performance as a function of personality variables. Phase II investigated additional behavioral correlates of noise environments plus specific biochemical substances indicative of physiological arousal. Phase III examined the effects of moderate noise levels on individual signal detection capability, and extended the work in depth of Phase II.

An annotated bibliography on Behavioral and Physiological Correlates of Varying Noise Environments from 1969 through 1974 was published as an ORD research report.

The final reports for Phase I, II, and III will also be published as part of ORD report series on health effects. The completion date for this project is October 1977.

Sponsor: EPA/ORD

Investigator: Dr. L. Sharp, Air Force Academy

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	60			

NOISE EFFECTS ON SLEEP

Correlational Analysis of Foreign and Domestic Data on the Effects of Noise on Human Sleep

This study provided a review of the recent experimental sleep and noise literature. It also provided some additional points to an earlier scatter plot to the frequency of no sleep disruption at various noise levels. A tentative composite measure of subjective sleep quality was proposed and its relationship shown to composite measures of the night time noise environment.

Sponsor: EPA/ORD

Investigator: J. Lucas, Stanford Research Institute

Fiscal Year Funding ($1000):	1975	1976
	16	

COMMUNICATIONS INTERFERENCE

Improved Criteria for Verbal Communication in Noise

This study provided measures of typical speech levels in homes, schools, hospitals, trains, airplanes and public places. Measurements were also made of speech levels in an anechoic chamber. Tabulations of 1/3 octave level statistical distributions of speech levels for the anechoic measurements are provided as data supplement. This study was completed in December 1976.

Sponsor: EPA/ORD

Investigator: K. Pearsons, Bolt, Beranek and Newman

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
	64			

Criteria for Noise in Buildings

Under an EPA/NBS IAG, NBS was contracted to undertake a critical examination of the various noise criteria and rating schemes in current use by building designers for indoor dwelling spaces. This analysis included a review of the origins of these human response criteria in order to determine their validity for possible incorporation in a forthcoming EPA Model Building Code.

Sponsor: EPA/ONAC

Investigators: S. Yaniv, D. Flynn, NBS

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	25			

COMMUNITY OR COLLECTIVE RESPONSE

Social Survey Questionnaire

Wyle Labs is reviewing over 30 selected, noise related attitudinal surveys. Emphasis has been placed on those community noise surveys which include an integrated physical and attitudinal monitoring program. The implementation methodologies and questionnaire designs within these surveys will be analyzed and evaluated. This examination should provide the necessary background documentation for development of a new comprehensive community attitudinal questionnaire. The questionnaire will become part of a community monitoring workbook for assessment of local noise problems and development of responsive local noise control strategies.

Sponsor: EPA/ONAC

Investigator: L. Sutherland, Wyle Laboratory

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			44	

Data Analysis - National Urban Study

An analysis of noise exposure and social survey data collected and tabulated in the National Urban Survey (EPA Contract No. 68-01-2275) was done. This previously compiled survey data had not been subjected to a full, systematic and detailed analysis before. The overall objectives of this program were (1) to establish relationships between noise exposure and human response as a function of situational and attitudinal variables associated with the life styles of people residing in urban areas away from airports and highways; (2) establish the outdoor noise levels at which noise becomes the salient factor in the generation of annoyance; (3) complete the baseline data bank for future evaluation of EPA effectiveness in fulfilling its responsibilities under the Noise Control Act; (4) further identify and establish, from a public health and welfare standpoint, a priority of products which require noise emission regulation and/or labeling.

Sponsor: EPA/ONAC

Investigator: S. Fidell, Bolt, Beranek and Newman, CA

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		40		

Guidelines for the Preparation of Environmental Impact Statements on Noise *

The objective of this study is to develop, in conjunction with the National Academy of Sciences/National Research Council Committee on Hearing, Bioacoustics and Biomechanics, guidelines for evaluating the effects of all types of environmental noise on the general population. When these guidelines are finished, they will be validated in order to show that they are correct and reasonable with respect to Air Force facilities as well as specifications, standards and regulations on noise exposure.

A working group of leading scientific/technical personnel is preparing these guidelines. Upon completion, they will be used to compare established predicted effects of noise on a community with actual measured behavioral responses.

Sponsors: EPA/ONAC, and Air Force

Investigators: H. Von Gierke, D. Johnson, AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		20	15	

Development of Guidelines for the Assessment of Large Impulsive Noises. (Community Annoyance Due to Mining and Quarrying)

The problem of an appropriate methodology for characterizing noise from large impulses and blasting (due to mining and quarrying operations), was raised as part of the CHABA EIS guidelines exercise. The sonic boom methodology described in the EPA Levels Document was applied to blast noise, and certain CHABA WG members disagreed. By 1975 the CHABA WG had agreed on this methodology - weighting with a nighttime penalty: "L_{cdn}." This rating scheme has been recommended to the Bureau of Mines. FY 77 and 78 funds will be used for validation of L_{cdn}. Through AMRL, EPA is trying to assure that there is a coordinated approach to the problem and that everybody (Bureau of Mines, Army, EPA, etc.) uses the same measurement methodology.

Sponsor: EPA/ONAC

Investigator: AMRL, Wright-Patterson AFB

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			5	

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* Jointly funded project. Only EPA funding is given here.

DOMESTIC ANIMALS AND WILDLIFE

Criteria Review of Effects of Noise on Wildlife

This project will provide a Summary/Update of research on the effects of noise on wildlife and other animals, since the publication of EPA's 1971 report on that topic (NTID 300.5, December 31, 1971). The Summary will be based on published literature and on the proceedings of a Symposium and discussion by experts (to be published independently).

In addition to reviewing the state of the art, the project is seen as providing impetus and direction for future research. Emphasis will be placed on the needs of governmental and other criteria-writing bodies.

Sponsor: EPA/ONAC

Investigator: J. Fletcher, University of Tennessee

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			15	

NOISE ENVIRONMENT DETERMINATION

Exposure of Motorcycle Operators to Noise

The objectives of this project are as follows:

- o develop, evaluate and refine a portable data acquisition system capable of determining noise levels at motorcycle operator and passenger ear position;
- o measure noise at motorcycle operator and passenger ear position;
- o summarize and analyze wind measurement data.

Sponsor: EPA/ONAC

Investigator: E. Odds, McDonnel-Douglas

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			20.5	

Noise Exposure Characterization Through Dosimetry *

The purpose of the present study is to test the feasibility of dosimetry as a practical method of assessing environmental noise exposures and to provide some samples (for 50 civilians) of typical daily exposures over the period of a week.

Plans are underway for a follow-up study of approximately 80 military personnel in a variety of occupations.

Sponsor: EPA/ONAC

Investigator: D. Johnson, University of Dayton, and AMRL

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		20	4	

Task on Assessing Noise Impact Attributable to the Operation of Household and Consumer Products

This work is being performed as part of an interagency agreement between NBS and EPA/ONAC. NBS is developing a conceptual model for assessing the impact of noise from household and consumer products on the health and welfare of the national population. Special attention is being given to the determination of a health and welfare criteria for the impact of these products in various environmental situations, e.g., single and multiple family dwellings, urban and suburban areas, etc., quantification of noise impact. Viable options for measurement and rating procedures will be examined and specific problem areas where further research or data are required will be identified.

Sponsor: EPA/ONAC

Investigator: Yaniv, National Bureau of Standards

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		45	19	

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* Jointly funded project. Only EPA funding is given here.

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

NATIONAL INSTITUTE OF CHILD HEALTH AND HUMAN DEVELOPMENT

NOISE-INDUCED HEARING LOSS

Specific Effects of Auditory Far Fields in Animals

Far field auditory evoked potentials can be detected on the scalp by averaging, and used as a measure of neonatal auditory system development in humans and animals, and the technique is now beginning to be used as a clinical measure. Many neonatal problems have been correlated with hearing loss in humans (e.g., ototoxic drugs, hyperbilirubinemia). It should be possible to detect auditory system damage from some of these causes in the neonate, at a time when corrective action may be effective.

The technique involves recording VIIIth nerve and brainstem electrical activity from surface electrodes by means of averaging the electrical responses to repeated auditory "click" stimuli. Changes in the obtained waveform can be observed during postnatal development of a single subject by repeated recordings during maturation.

This proposal is a continuation of our animal study, in which the many factors either known or thought to affect auditory far fields can be controlled. The specific factors we propose to study are: 1) ototoxicity, 2) hyperbilirubinemia, 3) prolonged exposure to loud noise, 4) cochlear damage in specific frequency ranges, 5) artifacts from other electrogenic centers, and 6) specific dietary deficiencies.

Investigators: D.L. Jewett, V.L. Schwent, J.S. Williston, R.G. Plantz, University of Southern California

Fiscal Year Funding ($1000):	1976	1977
	48	61

NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES

NOISE-INDUCED HEARING LOSS

Auditory Effects of Long Exposure to Low Levels of Noise

The major objective is to specify the quantitative and qualitative relations between the physical characteristics of noise and the temporary hearing losses produced by te noise. Knowledge of these relations will permit the specification of levels of noise that will not injure the inner ear, will help produce a temporary hearing loss, and will not delay the decay of an existing hearing loss. In addition, these relations will provide scientific bases for the development of noise standards and criteria. Human observers will be exposed to low levels of continuous and intermitent noises for a period of up to 48 to 1 hrs. Auditory sensitivity for pure tones as well as other tests of auditory function will be measured before an exposure, during quiet periods interspersed within an exposure, and after an exposure. Results will be evaluated with respect to previous human and sub-human data, a predictive model (the Equivalent Power Model), and current noise standards and criteria.

Investigator: Prof. J. H. Mills, University of South Carolina

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	58.6	63	60	

Combined Impulse Continuous Noise - Auditory Effect

Combinations of non-traumatic impulse and continuous noise can produce unusually severe changes in hearing sensitivity and cochlear integrity. The extent of this noise-induced trauma cannot be explained on the basis of addition of te acoustic power of the two noises. The purpose of the proposed research is to systematically study the effects of combined impulse and continuous noise exposure on hearing sensitivity and cochlear anatomy. Three impulses of variable intensity, spanning a temporal range from 40 microsec. to .3 sec., will be individually studied in combination with various intensities and band widths of a background of continuous noise. Chinchilla will be used as experimental animal. Noise-induced temporary and permanent threshold shifts will be measured at regular intervals after exposure using the auditory evoked response measure. At thirty days after exposure, the cochlear cell populations will be analyzed using phase microscopy thin sectioning techniques and electron-miscroscope. The final evaluation of the particular noise exposure will depend on a correlation of the noise parameters with the audiological and histological changes. The ultimate objective of this research is the establishment of a Damage Risk Criterion for impulse-continuous noise combinations.

Investigators: R. P. Hamernik, D. Henderson, State University of New York

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979
	35.4	39.4	40	36	38

Effects of Noise and Otoxic Agents on Energy Balance and Metabolism in Cochlea.

The purpose of this project is to increase the understanding of selected basic auditory mechanisms under normal conditions and under the influence of sensory disorder and physical/chemical agents. The present topics are: (1) permeability of cochlear partitions to sodium and potassium ions, and (2) effect of locally applied ototoxic agents on cochlear potentials (3) effect of noise on permeability of cochlear partition and energy balance.

Investigators: T. Konishi, P. J. Walsh, P. E. Hamrick, A. Yankwich, A. Salt, NIEHS.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		35	25	40

Effect of Otoxic Insult on Coding of Complex Signals in the Auditory System

Results of behavioral nd audiological tests with humans imply that ability to understand speech and other complex signals (particularly in a noisy listening situation) suffers loss from noise insult in excess of what could be inferred from pure tone thresholds measured in the quiet. These findings suggest that a complex interaction both between the various levels of the auditory nervous system itself, and between the auditory nervous system and various receptors of the auditory end organ play a vital role in "sharpening" the sensory process. Until recently it has not been possible to study the effect of noise insult on rapidly changing speech or speech-like signals because such study necessitated the use of extremely fast-acting signal analysis (frequency domain) equipment coupled with the memory capacity of a minicomputer. The PDP 11440 Minicomputer in our lab is being interfaced with signal analysis equipment for processing electrophysiological data by Fast Fourier Transformation Auto and Cross Correlation analysis. The responses from both multi cochlear microphonic (UH) and responses from individual nerve fibers of noise exposed and non-noise exposed animals will be obtained.

Investigator: R. Cook, T. Konishi, NIEHS

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		40	40	20

Physiological Study of Auditory Fatigue

The cochlear microphonic, whole-nerve action potential and nerve impulses of single auditory nerve fibers, are to be recorded and measured in anesthesized guinea pigs and cats. The recovery processes of the receptor potential and neural responses will be examined after sound exposure. The effects of both exposure tones (duration, intensity, and frequency) and test tones (intensity and frequency) on the recovery curve, ought to be tested. The same experimental paradigms ought to be used in guinea pigs or cats which have been treated with subtoxic doses of kanamycin (200 mg/Kg, 5 days) in order to test the possible potentiation effect of the antibiotic in the auditory recovery process after sound exposure.

Investigators: T. Konishi, R. Cook, A. Yankwich, NIEHS

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	26	26	26	26

Mechanical Impulse Noise Generator for Hearing Loss Experiments

In many cases industry and transportation noise contains contributions from sounds of an impulsive nature with a very short duration and of high intensity, which do not effect the measured total noise dose significantly. Also, people subjected to discotheque sound at 110-115 dBA are reported to suffer less loss than experienced by others similarly exposed in occupational settings. Many other similar examples demonstrate the need to investigate why these differences exist. It has been suggested that the sharp peaks associated with mechanical impacts in industry may be the decisive parameter. Reproduction of sounds with a very high peak and of short duration is not possible electronically, i.e., neither tape recorders nor speakers can recreate these sounds. The objective of this project is to design a mechanical impulse noise generator for use in laboratory (animal) hearing loss experiments. This particular device should be simple to operate and will have the advantage of controlling the parameters of the generated sound including peak level and frequency content.

Investigators: A. Akay, R. Cook, NIEHS

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			15	1

Detection of Single Unit and Other Response After Exposure to Naturally Ocurring Complex Auditory Stimuli

Pure tones are different from the stimuli to which biological systems usually are exposed. The purpose of this project is to study the dynamic properties of the auditory system of rats or cats after exposure to the pseudorandom noise. Pseudorandom noise is similar to the natural stimulation which the auditory system processes. Cross-correlation and unit impulse responses are determined before and after exposure to the pseudorandom noise. The relation between unit impulse and parameters of noise exposure will be studied.

Investigators: Konishi, Cook, Hamm

Fiscal Year Funding ($1000)	1975	1976	1977	1978
			25	35

NON-AUDITORY HEALTH EFFECTS

Effects of Noise Stress on Developing Mouse Embroyos

Several studies have indicated that noise combined with other forms of stress is teratogenic in mammals if the pregnant female is exposed during critical periods of fetal development. One study indicated that noise alone was capable of producting teratogenic effects. The reported effects have varied widely, however. To determine the source of this variability, this experiment is designed such that the stress was limited to noise alone and the effect of high level steady state noise can be compared with that produced by random onset, moderate level impulsive type noise (controlled by a minicomputer). Typically encountered sounds (jet noise, alarm bells, etc.) are used as stimuli instead of white noise. Corticosterone levels are to be monitored in both control and experimental animals. The teratogenic potential of the noise exposures will be determined by comparison of the fetuses of control and noise exposed animals for evidence of external visceral and skeletal alterations.

Investigators: R. E. Staples, PH.D., P. S. Nawrot, Ph.D., R. O. Cook, Ph.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			58	

Protracted Noise Exposure and Cardiovascular Function*

Quantitative criteria for the effects of noise of the cardiovascular system are needed in order to protect the health and welfare of the American Public from adverse effects of noise. Research on the non-auditory physiological effects of noise has been identified as a particularly pressing need. Preliminary results show that prolonged exposure to moderate noise levels, such as urban traffic noise, caused significant increases in heart rate in a female Rhesus monkey. The heart rate had still failed to return to normal 4 months after the noise had stopped.

Sponsors: NIEHS, EPA/ONAC

Investigator: P. Peterson, University of Miami

Fiscal Year Funding($1000):	1975	1976	1977	1978
			30	44.3

Noise and Cell Mediated Immunity

This was an investigation of the possible effects of noise, both constant and intermittent, on the ability of rats to develop de novo sensitization to PPD. In addition, cell mediated immunity after noise was studied in vitro by lymphocyte stimulations.

Investigators: S. Fox, R. Q. Cook, NIEHS

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	25			

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*Jointly funded study. Only NIEHS funding is given here.

COMMUNITY OR COLLECTIVE RESPONSE

Personal and Family Adjustment to Urban Noise

This was an exploratory study of the psychological impact of a new community noise problem. Residents of a community in which a section of the Interstate Highway System was under construction were interviewed before the highway was completed, shortly after traffic began, and then again four to six months later. The investigation focused on the emotional distress and behavioral disturbances which occur and the difficulties individuals experience in adjusting to the noise. The effects of noise were interpreted within the framework of theories of psychological stress and coping. Questions asked during the interviews concerned attitudes toward the community affective responses to the noise, and the different methods of direct and intrapsychic coping people use. The goals of the project were to describe the initial short term effects of the noise, to describe level of the adjustment achieved several months later, to test and develop hypotheses about the factors which influence individual differences in sensitivity to noise, to test and develop hypotheses about the relationship between different coping mechanisms and eventual adaptation, and to contribute to the understanding of the significance of noise as an urban mental health problem.

Investigator: N. D. Weinstein
Rutgers State University

Fiscal Year Funding ($1000):	1976	1977	1978
	35		

NATIONAL INSTITUTE OF NEUROLOGICAL AND COMMUNICATIVE DISEASES AND STROKE

NOISE-INDUCED HEARING LOSS

Effects of Noise

This project is part of a broader program (NS 03856-14) whose summary states: Psychophysical studies of auditory patterns, including discrimination of components within sequential patterns, recognition of melodies, and discrimination of temporal aspects. Electrophysiological studies of non-linearities in the response of the inner ear. Evoked corical potentials of short latency and their utility in clinical evaluation. Behavioral studies of speech-sound discimination in animals, young infants and normal and hearing-impaired adults. Effects of noise exposure on behavioral, physiological and anatomical aspects of hearing. Computer-assisted analysis of speech and voice production, and of auditory and non-auditory recognition of speech. Early developmental steps in the language skills of hearing-impaired children.

Current noise projects include Irreversible inner ear damage from rock music, using six chinchillas taken to a discotheque and exposed to live "rock" music; Physiological correlates of cochlear injuries following exposure to noise; Mechanisms of noise damage in the inner ear, testing the theory of noise damage, Healing of the noise-damaged ear, (steps leading to the formation of mature phalangeal scars after hair cell degeneration); Growth of cochlear damage with increasing exposures.

Investigator: D.H. Eldredge, Central Institute for the Deaf

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	219	226	210	210

Causes of Deafness

This project is concerned with the normal physiology of the ear and the pathological conditions that result in deafness. The basic purpose of this program project is to provide the logistic support of the Kresge Hearing Research Institute to individual investigators.

Many laboratories utilizing different techniques are involved in this study of the causes of deafness. Microcirculation of the ear in normal conditions and under the influence of ototoxic drugs, noise and congenital abnormalities are studied by closed circuit television in relation to the energy transformation ability of the ear. Monkeys are trained so that thresholds and recruitment determinations can be made on them. These animals are used in studies of the pathology of ototoxicity, temporary and permanent threshold shifts. The chemical alteration of fluids and cells is analyzed and the architectural pathology is determined by histological surface preparation, transmission and scanning electron microscopy. Various psychoacoustic properties of hearing are also investigated.

Investigators: M. Lawrence, D.J. Anderson, T.D. Clack, N.B. Gross,
J.E. Hawkins, University of Michigan

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	189	201	243	

Cochlear Nerve Degeneration in Deafened Ears

The objective of this research is to obtain a clearer estimate of the size and extent of the surviving population of cochlear nerve fibers in the ears of deaf patients who might be considered as candidates for an auditory prosthesis designed to bypass the organ of Corti and deliver electrical stimulation directly to the nerve fibers. The purpose is to study temporal bones obtained at autopsy from patients known to have been deafened by noise exposure, ototoxic drugs, aging, or viral disease, and to measure the extent of loss of both sensory and neural structures, including the organ of Corti, the myelinated dendrites in the osseous spiral lamina, the cells of the spiral ganglion, and the axons in the modiolus. The techniques of microdissection and phase-contrast examination of surface preparations are employed, followed by sectioning of the decalcified modiolus embedded in celloidin. Monkeys and chinchillas trained for behavioral audiometry are used as animal models. After measurement of their normal thresholds for pure tones they are deafened by ototoxic drugs, noise exposure, or combinations of the two that are known to produce extensive injury to cochlear structures. When their residual hearing, if any, has been measured audiometrically, the animals are kept for varying periods up to 3 years, then sacrificed for post-mortem study of the inner ears to determine the extent of cochlear injury and degeneration, and the degree to which the cochlear nerve fibers have survived. Information from this research should be helpful in predicting the likelihood of long-term success for the use of implanted cochlear prostheses in various forms of acquired deafness. Similarly, Dalmatian dogs are used as animal models for studying cochlear nerve degeneration in hereditary and congenital deafness.

Investigators: L. Johnson, J.E. Hawkins, R.E. Preston, University of Michigan

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	46	76	51	

Core Program Project in Communicative Disorders

This program consists of interdisciplinary projects in four areas: (1) Preservation of the cells lining the cochlear duct and the junctions between them, (2) Ototoxic effects of salidiuretics and antibiotics, (3) Short and long-term effects of overexposure to noise, (4) Presbycusis and other age-related changes in the ear. Approaches to these studies utilize electrophysiological measures of cochlear function along with morphological and biochemical assessment of the condition of the stria vascularis and organ of Corti following the different experimental treatments. In many cases, the same animal is used for two independent measures of cochlear function (i.e., electrophysiology and biochemistry) so that the effect of physical changes in cells can be related to changes in their function.

Investigator: J.H. Ogura, Washington University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	170	156		

Damaging Effects of Noise and Pure Tones (Guinea Pigs)

This project is part of a broader program (NS 09889-05A1) whose summary states: The purpose of the Kresge Hearing Research Laboratory is to conduct intradisciplinary studies of the clinical problems produced by damage to the ear. The objective of these investigations are to first identify agents which exert deleterious effects upon the ear; then attempt to understand the mechanism by which the damage is produced and finally seek ways to provide protection from, or relief from, or compensation for the damaging effects. The identification and understanding of agents producing damage includes those agents which interact with each other to produce damage as well as the single offenders to the ear.

The methods of investigation involve the use of animal models as well as human subjects. The techniques utilized are: 1) recording of electrophysiological events in the auditory system: AC cochlear potential, endolymphatic potential, N1 action potential of the VIIIth nerve, single unit activity of the IIIth nerve and evoked responses in the auditory cortex. 2) behavioral measures of hearing in animals using operant conditioning techniques, 3) histological assessment of the inner ear including hair cell counts by the surface preparation technique, serial sectioning using celloidin embedding and electronmicroscopy.

Investigator: M.B. Meikle, University of Michigan

	1975	1976	1977	1978
Fiscal Year Funding ($1000) :		138	87	

The Determination of Susceptibility to Hearing Loss

The relations among (1) temporary loss of auditory sensitivity, or temporary threshold shift (TTS), (2) permanent threshold shifts (PTS), and (3) damage to cochlear structures caused by exposure to noise will be studied in the chinchilla, with the ultimate goal the prediction of susceptibility of a given ear to PTS and/or to structural damage on the basis either of TTS data or of other measurements that can be made on the intact organism. Studies similar to those already conducted on the sequelae of a relatively broad-band noise will be performed using narrow-band noises. Considerable effort will be devoted to study of the equal-energy hypothesis(which postulates that PTS and cochlear damage depend only on the total relevant acoustic energy absorbed by the ear, regardless of temporal pattern of the noise), because of the practical significance of this principle in regard to damage-risk criteria. The physiological processes associated with recovery from severe noise exposures will also be studied by electron microscopy, particularly the development, shortly after exposure, of small osmiophilic particles and larger inclusion bodies (thought to be deposits of glycogen) in the stria vascularis. Possible changes in permeability of cochlear partitions immediately after intense noise will be studied by means of the tracer horseradish peroxidase. The influence on TTS and PTS of certain medications said to ameliorate the effects of acoustic trauma will also be investigated. This project has been taken over by NIOSH.

Investigator: W.D. Ward, University of Minnesota

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	64			

Development of Neural Mechanisms in Hearing

This research concerned the course of development of auditory processing in brainstem centers and the susceptibility of this development to changes induced by manipulations of the early sound environment. Rats served as experimental subjects for acute unit recording at the cochlear nucleus and inferior colliculus. Manipulation of the auditory history of individual animals included deprivation and controlled exposure to experimental sound environments. The objective was to characterize the neural events leading to adult auditory processing and to determine their vulnerability to plausible extremes of sound experience.

Investigator: B.M. Clopton, University of Washington

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		17	71	

Disorders of Cochlear Homeostasis and Function

This project has as its objective the exploration of possible means of minimizing permanent hearing loss caused by noise and ototoxic drugs through treatment based on improved understanding of cochlear metabolism and pathophysiology. It begins with the hypothesis that the early stages of cochlear injury represent a disturbance of the microhomeostasis and may be reversible by enhanced blood flow and oxygenation, greater availability of metabolites, or accelerated removal of waste products. This hypothesis will be tested in the guinea pig cochlea after noise exposure and ototoxic drug administration sufficient to cause slight depression of the cochlear potentials without hair cell loss. Cochlear perfusion will be carried out with artificial perilymph, with and without the addition of oxygen, glucose, CO_2, or vasoconstrictive drugs, while cochlear microphonic and action potentials are being recorded. Similar measurements will be made in animals which will receive plasma volume expanders, ergot alkaloids, increased CO_2, etc. without cochlear perfusions. Parallel studies of cochlear biochemistry will be carried out to elucidate the processes involved in the actions of noise, aminoglycosides, diuretics and combinations of those agents on hearing. This aspect of the research will also focus on the quantitative determination of drug concentrations in cochlear fluids and tissues and on the assay of adenyl cyclase and cyclic AMP, in an effort to establish their roles in relation to cochlear injury by noise and ototoxic drugs.

Investigators: J.E. Hawkins, J.H. Schacht, University of Michigan

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		58	38	

Latency-Intensity Functions in the Auditory System

In using the nonhuman primate as an auditory model for man, it is hoped a more precise understanding of the nature of hearing loss due to intense sound and noise and ototoxic drugs may be obtained. For example, the conditions which produce broad band versus frequency specific hearing loss, either reversible or permanent in nature, may be specified. The cumulative and combined effects of both drugs and noise are examined. Particularly important is the relation between hearing impairment and cochlear and brain stem histopathology.

Behavioral conditioning methods, together with audiometric testing procedures (i.e. Bekesy audiometry) are used for threshold testing, for frequency and intensity difference thresholds, and for assessment of the discimination of loudness levels in the study of recruitement. Monkeys with a clearly established hearing loss as a consequence of exposure to intense sound or drug treatment are sacrificed and histological changes in the cochlea and cochlear nucleus of the brain stem are compared with the final audiometric results.

Investigators: W.C. Stebbins, D.B. Moody, University of Michigan

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		114	79	

Mechanisms of Hearing Loss

The research initiates investigations into the mechanisms of hearing loss, with particular emphasis on the processes involved in hearing loss caused by exposure to noise and by chemical toxins. In addition, a major portion of the research is concerned with the identification of auditory and vestibular deficits associated with specific etiologies of hearing loss, in order to provide a better basis for differential diagnosis of auditory disorders.

Data obtained from research techniques in electron microscopy, psychoacoustics, biochemistry, neurophysiology, vestibiluar physiology, light microscopy, histochemistry and immunology, as well as those in clinical medicine, will provide the basis for accomplishment of the primary goals of this research program, namely: the understanding of the mechanisms of hearing loss and the improvement of methods of management of patients with hearing loss.

Investigators: M.M. Paparella, W.D. Ward, M.J. Capps, D.A. Nelson,
A.J. Duvall, University of Minnesota

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	225	226	182	

Microscopic Studies of the Inner Ear

Human temporal bones obtained at autopsy from patients with various forms of sensorineural deafness are studied by microdissection and phase-contrast examination of surface preparations for correlation of audiological and pathological findings. Similar studies are carried out in monkeys treated with ototoxic aminoglycosides and other drugs, for which complete behavioral audiograms have been obtained before, during, and after treatment. The patas monkey is studied as a model for drug ototoxicity in man, because it alone among laboratory animals has been found to be susceptible to the ototoxic action of dihydrostreptomycin at dose-levels similar to those formerly used in treating human tuberculosis. Structure-activity relationships for various aminoglycosides, enzymatic modifications, and fragments, are explored in guinea pigs, as is the possible relationship between salicylate ototoxicity and prostaglandin effects on the inner ear microvasculature. The question of potentiation of cochlear injury by combinations of aminoglycoside treatment and noise is explored in monkeys. Temporary and permanent threshold shifts and accompanying cochlear changes are examined in monkeys exposed to recorded industrial noise from automotive factories and to impulsive noise from power-actuated tools used in the construction industry.

Investigators: J.E. Hawkins, L. Johnson, University of Michigan

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		29	22	

The Perception of Complex Auditory Stimuli by the Deaf

This project is now in its twelfth year. The object of the research, since the inception of the project, has been to gain an insight into the nature of speech perception in the severely hearing-impaired population. Logically, though not temporally, the work began with an analysis of the confusion matrices of deaf listeners. Results of these researchers and others show consistenetly poorest performance on discrimination of place cues. The approach of Pickett's group was to attempt to analyze the failures of discrimination which would lead to this result. Since the Haskins group had shown that the discrimination of place depended on the first and second formant transition, work was begun on attempting to examine these variables, particularly the latter, in deaf listeners. An early result was that sensorineural subjects have great difficulty in discriminating F_2 transitions, because of the presence of F_1, which seems to exert an effect like the upward spread of masking. Forward and backward spread effects can also be seen. The group has gone on to explore these effects in some detail. The early work was done mostly on students at Gallaudet College. More recently, similar work has been done on a presbycusis population.

Investigator: J. Pickett, Gallaudet College

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	87	90	112	102

Response of Inner Ear to Injury

The goal of this project is to elucidate the reversible and irreversible morphological alterations which may occur in the cells lining the cochlear duct of the inner ear after its having been subjected to noise or chemical trauma, ischemia, anoxia or hypoxia. The possibility of changes in permeability of these cells or the junctions between them following different experimental treatments will also be investigated. The ultimate goal of this work is to elucidate the mechanisms of injury of various traumas to the inner ear.

Evaluation of damaged inner ears includes an overall survey of the embedded flat preparations by phase contrast microscopy so that complete cell counts can be made and percentages of missing or severely damaged cells can be calculated. This is followed by sectioning of selected areas of damage at radial, horizontal or tangential angles for light or electron microscopic examination.

Investigators: B.A. Bohne, R. Thalman, C.D. Carr, Washington University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		45	38	

Outpatient Research Center for Sensorineural Deafness

Attention is given to those sensorineural involvements where causes are not readily apparent. Special attention is given to symptom complexes which will help to differentiate peripheral from central lesions, and various central lesions from each other. Considerable stress is placed on attempts to differentiate central from peripheral bases for the disorder which falls under the broad rubric of presbycusis.

The research group sees the diagnosis of "presbycusis" as one of exclusion, it is a nosologic entity without definite audiological characteristics. The overall concept of examining patients who have a diagnosis of "presbycusis" is an attempt to define what, if any, subgroups exist in the entity. The research group is looking at these patients utilizing their entire testing armamentarium with the hypothesis that there may be some psychoacoustic and/or physiologic correlates of Schuknecht's four categories of presbycusis (i.e., change in resiliency, loss of hair cells; loss of spiral ganglion cells and atrophy of the stria vascularis). They have added a fifth possible entity of presbycusis, that of central neurologic origin.

The data which is gathered should lead to information as to whether there are manifest, with present techniques, different subgroups in the so-called group of presycusities. There should also be some measure as of the relative incidence of the different subsets.

The concept of a central mechanism of presbycusis may be very significant and is of importance in rehabilitation of these people. The experience and expertise of this group in the area of brainstem and central auditory disorders is of greates importance in the evaluation of these patients.

Investigator: P. Noffsinger, Northwestern University

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			103	

Studies of Auditory Sensitivity and Discrimination in Very Young Children

This contract was awarded to study auditory sensitivity and discrimination in children 0 to 6 years of age. Phase I is a two year project to investigate and develop various measures which could be used to assess such auditory functioning. Phase II involves making use of the measures and techniques refined during Phase I to collect baseline data on the auditory sensitivity and discrimination of young children. The goal is the development and evaluation of a battery of tests which can be used to characterize the hearing ability of young children not suspected of having hearing deficits and to examine the feasibility of using such a battery to assess the hearing of infants and young children who are suspected of or are at risk for hearing dysfunction. Measures which have been or are being investigated are: brain stem evoked responses, auditory supression of startle blink responses, behavioral measures, (clinical and non-clinical) cardiac rate changes, and non-nutritive sucking. The first three of these measures are presently under intensive investigation.

Investigators: W.K. Berg, D.C. Teas, University of Florida

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	116	115	134	

COMMUNICATION INTERFERENCE

Binaural Speech Reception

The purpose of this research is to study some basic auditory factors that may affect speech reception by hearing-impaired persons under noisy reverberant conditions.

The auditory factors are: 1) the echo-integrating capacity of the auditory system and 2) the spatial, separating function of the binaural system. Echo integration refers to the known capacity of the auditory system to summate, for receptual purposes, a direct speech signal and an echoed (delayed) version of the same signal. The binaural aspect of hearing also enhances speech reception in noisy rooms and may interact with echo integration.

We propose to investigate how echo integration and binaural hearing together affect speech reception. Speech reception tests will be carried out in rooms with variable reverberation and also under controlled echo conditions simulated by a computer. Various speech-to-noise ratios will be used and the tests will be carried out both monaurally and binaurally. Noises will be : 1) a voice babble and 2) impulse noise. Tests will be performed on normal listeners and on listeners with sensorineural impairment of hearing who are wearing hearing aids. Normal listeners will be tested both with and without hearing aids. We expect the results to have important implications for auditory theory, for the acoustic design of rooms, and for the use of hearing aids.

NINCDS (Continued)

Investigators: A.K. Nabelek, L.W. Asp, C.E. Shipley, Univ. of Tenn.

Fiscal Year Funding($1000):	1975	1976	1977	1978
	34	68	57	

NATIONAL INSTITUTE OF OCCUPATIONAL SAFETY AND HEALTH

NOISE-INDUCED HEARING LOSS

Control Techniques for Hearing Conservation

This was a two year study directed towards the control of occupational hearing loss through improving the state-of-the-art of hearing conservation practices including audiometric tracking of hearing loss, improving the effectiveness of ear protectors in actual industrial situations, and engineering and administrative control.

Plans for this project included a study of impairment criteria for the development of more accurate measures of hearing, diagnostic and audiometric testing to identify persons susceptible to noise induced hearing loss, a review of the state-of-the-art of automated audiometry and data processing, performance tests of ear protectors in industrial situations using a new measurement technique, and consideration of administrative and engineering noise controls for promulgation of comprehensive criteria for occupational noise exposure.

Investigator: R. Flemming, P.H.S. Center for Disease Control,
Cincinnati, OH

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	78	97			

Damage Risk Criteria for Intermittent Noise Exposure

Present damage-risk criteria (DRC) for daily 8-hour exposure to intermittent noise are based on extrapolation from meager data. It is certain that the equal-energy hypothesis traditionally used (a hypothesis that assumes that the temporal pattern is irrevelant and that only the total energy matters) leads to DRC that are too conservative, since no account is taken of the recuperative powers of the ear between noise bursts. On the other hand, a recent American DRC sponsored by the Committee on Hearing, Bioacoustics and Biomechanics (CHABA) of the National Research Council may not be conservative enough, according to empirical evidence that has since accumulated. Therefore it is proposed to determine DRC for intermittent noise directly, based on the assumption that any pattern of noise exposure over an 8-hour period is safe if the auditory fatigue (temporary threshold shift, or TTS) thereby produced has disappeared after 16 hours of rest. Normal-hearing young adults will be exposed for 6 or 8 hours to noise patterns with duty cycles ranging up to 50 minutes, with on-fractions of 1/2, 1/4, 1/8, etc. The intensity level for each such pattern will be gradually increased in successive sessions until the particular TTS is produced that just barely recovers in 16 hours. DRC based on the results will then be constructed.

Investigator: W. D. Ward, University of Minnesota

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
	47	41		49.6

The Effects of Impulse Noise on the Auditory System

The purpose of this research is to develop an empirical basis for an impulse noise Damage Risk Criteria. The strategy behind the research is to determine the relation between the parameters of the impulse and the concomitant changes in hearing and cochlear histology using chinchillas as test subjects. The parametric study of impulse noise will be followed by low-level, long-term exposures and will more closely model realistic noise environments. This data is a necessary prerequisite for the determination of what constitutes a potentially hazardous impulse noise environment and how to audiometrically evaluate the hazard, and will ultimately contribute to the establishment of a safe Damage Risk Criteria.

Investigator: D. Henderson, E. A. Blakeslee, R. D. Hamernik, and R. J. Salvi, State University of New York, Syracuse

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
		107.4		68.6

Evaluation of Hearing Risk Due to Industrial Noise

This study was done to determine parametric relationships between noise exposure and hearing loss with particular emphasis on the effects of impact noise, shortened exposures to higher noise levels, intermittent noise, lengthened exposures, seasonal exposures and noise spectrum. It included epidemiological studies, computer analysis and literature research. The investigator proposed to identify primary sources of industrial noise, collect audiometric data for statistical analysis, study formulae for predicting or assessing hearing risk due to noise, and conduct industrial noise surveys to obtain data on the prevalence and characteristics of noise exposure. In addition a handbook was to be prepared for selection of sample populations and data analysis for industrial, audiometric studies.

Investigator: T. L. Henderson, P.H.S. Center for Disease Control, Cincinnati, OH

Fiscal Year Funding ($1000):	1975	1976
	104	

Hearing Conservation Methodology

Activities under this project are directed toward protecting industrial workers from hearing loss caused by occupational noise exposure. Hearing conservation programs are the central theme, with special emphasis on the use of hearing protectors on-the-job. A technical report will be finalized for publication which contains guidelines for implementing hearing conservation programs. Insert-type hearing protectors are being evaluated for their on-the-job effectiveness in reducing noise exposures. The effects on performance of such factors as physical activity, company policy, protector category, noise level, and wearing time are being investigated under an FY'76 contract awarded at the year's end. This work will lead to determining the adequacy of current procedures for rating hearing protector attenuation (including those in the NIOSH noise criteria document.)

Investigator: B. Limpert

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
				25.4	32.9

Impact/Impulsive Noise Data Base

This is a laboratory animal study being done to determine the effects of impact/impulsive noise. Results of these experiments will be correlated with human data acquired from occupational noise and hearing surveys. The use of an animal data base is essential since occupational exposures to impulsive noise are too variable to permit adequate determination of risk criteria from epidemiological data. Laboratory work using human subjects has been limited to temporary effects studies for which no relationship has been established to predict chronic effects. Moreover, there has been increasing concern over the safety and propriety of such human subjects studies in recent years.

Investigator: B. Limpert, P.H.S. Center for Disease Control,
Cincinnati, OH

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	92.8	122.9		85	149.9

Laboratory Studies of Noise-Induced Hearing Loss

Studies of temporary and permanent hearing losses in animal subjects and temporary hearing loss in human subjects were conducted in order to determine effects of impact noise, fluctuating noise levels, quiet rest periods, shortened exposures at higher levels, intermittent noise, lengthened exposures, and noise spectrum. In order to study the effects of the aforementioned types of noise on human subjects, evaluations were made of central and peripheral nervous system effects, middle ear dynamics, and noise effects on receptive auditory communication.

Investigator: D. Dunn, P.H.S. Center for Disease Control,
Cincinnati, OH

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
	91	27		

Noise-Induced Hearing Loss (Human Studies)

An analytical in-house literature study of the hearing loss effects of impulse/impact noise will be conducted. Based on occupational impact noise sources identified for NIOSH, 100 workers will be selected to undergo clinical audiometric tests. Results will be correlated with data derived from animal impulse noise exposures, and an interim report will be submitted concerning the auditory effects of impulse/impact noise on the human auditory system.

In addition, a clinical evaluation of middle-ear disorders in selected coal miners will be performed under Contract #CDC-99-OSH-83, Prevalence of Middle-Ear Disorders in Coal Miners, already underway.

Investigator: D. Dunn, P.H.S. Center for Disease Control,
Cincinnati, OH

Fiscal Year Funding ($1000):	1975	1976	TQ	1977
				36.7

The Effect of Noise on Hearing - Critical Issues

A 3 day symposium was held to discuss critical issues in developing scientifically based damage risk criteria for noise. Authorities from psychoacoustics, audiology, engineering and public health were invited to deliver state-of-the-art essays on key questions concerning the generation of noise standards. The proceedings of the symposium were to be published, to serve as a handbook for future investigators and individuals concerned with the public health aspects of noise pollution.

Investigators: D. Henderson, R. P. Hamernik, D. S. Dosanjh, J. H. Mills,
State University of New York, Syracuse

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	28.3			

Study of Noise/Hearing in the Paperworking Industry

This study, which was initiated in late 1973 following a request by the United Paperworkers International Union, has been started in paper plants in the Greater Cincinnati area.

The study involves hearing tests and intermittent noise exposure measurements on approximately 2,700 noise exposed paperworkers in two age groups and hearing tests on approximately 400 non-noise exposed controls. Hearing tests are given in the NIOSH mobile hearing laboratory. Intermittent noise measurements will be documented using the NIOSH-developed noise chrono-dosimeter system.

The goal of this project is to fill research gaps relating to non-steady noise identified in the NIOSH Criteria Document on Noise and the OSHA recommended standard. The study will be expanded to other industrial classifications if the data from the paperworking industry do not sufficiently bracket the range of intermittency of noise prevalent throughout industry.

Investigator:

Fiscal Year Funding ($1000):	1975	1976	TQ	1977	1978
	41	37		63	64.4

NON-AUDITORY HEALTH EFFECTS

Extra-Auditory Effects of Noise

This was a 3 year project completed in FY 1976. The purpose of this study was to determine if occupational noise exposures can cause extra-auditory behaviorial problems and other disturbances of consequence to worker safety and health, and whether noise limits designed to conserve hearing can nullify these effects.

The planned work included a Contract study to examine the effects of steady state and impact noise levels deemed safe for hearing by NIOSH on visual, tactile, vestibular, vibrotactile, and thermal sense functions. Other work was to concentrate on the effect of the same noise exposures on task performance necessitating divided attention. Another study was to investigate the effects of a new hearing conservation program in reducing employee absenteeism, accidents, somatic disturbances found in records of workers engaged in the noisiest jobs in a given plant.

Investigator: A. Cohen, NIOSH

Fiscal Year Funding ($1000):	1975
	95.6

NOISE ENVIRONMENT DETERMINATION

Measurement of Occupational Noise

The aim of this study was to design and test a dosimeter which allows for the retention of noise and time duration data as well as accumulated dose over an 8 hour period. The dosimeter was to be tested in field use in conjunction with the project on noise and hearing in the paperworking industry.

NIOSH (Continued)

The use of available noise dosimeters continues to create problems with established standards which are based on sound level meter measurements. A need exists for a dosimeter which allows the retention of noise and time duration data as well as the accumulated dose over an 8 hour period. Prototypes of such a device will be designed and tested in field use in conjunction with the project on noise and hearing in the paperworking industry. This project was completed in 1976.

Investigator: R. Willson, NIOSH

Fiscal Year Funding ($1000):

1975	1976	1977	1978
28.3	37.8		

NOISE INDUCED HEARING LOSS

Evaluation of Methods for Calculation of Attenuation Factors of Ear Protectors

Currently, many miners are wearing personal hearing protection devices. For the MESA inspector to accurately determine the noise exposure of the worker, he must know the dBA attenuation (R-factor) of a particular protective device. To this end, the Branch has been evaluating various methods for calculating effective R-factors. In addition, several commercially available hearing protectors have been evaluated through the use of laboratory as well as actual field testing.

Sponsor: DOI/MESA

Investigator : L. Marraccini, Pittsburgh Technical Support Center

Fiscal Year Funding ($1000)	1975	1976	1977	1978
	2	3	3.2	3.5

Evaluation of Ear Protectors in the Workplace

This is a planned 1978 study which will be done to determine the actual attenuation factors of ear protectors in a mine environment.

Sponsor: DOI/BOM

Investigator: Pittsburgh Technical Support Center

Fiscal Year Funding: ($1000)	1978
	50

Evaluation of Speech Processing Systems

The purpose of this program was to develop both methods for testing and evaluating electronic ear protectors. These methods are used to measure the performance of currently operational electronic ear protective systems, and to compare the performance of competitive systems.

Sponsor: DOI/BOM

Investigators: P.L. Michael, J.H. Prout, Pennsylvania State University

Fiscal Year Funding:($1000):	1975	1976	1977	1978
	62.7	10.2		

DOI (Continued)

COMMUNITY OR COLLECTIVE RESPONSE

Noise Abatement in Substations

The objectives of this project are to:

- establish source and transmission characteristics for circuit breakers;
- liaison with other interested groups;
- correlate community reaction to impact noise;
- investigate noise reduction possibilities;
- conduct a literature survey;
- perform field measurements.

The estimated completion date for this work is 1978.

Sponsor: DOI/Bureau of Reclamation

Investigator: T.H. Logan, DOI

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	3.8			

NOISE ENVIRONMENT DETERMINATION

Calibration of Sound Level Meters and Noise Dosimeters

MESA is mandated to perform noise measurements with accurately calibrated noise instrumentation. The Noise Branch intends to develop an instrumentation system for calibrating sound level meters and audio dosimeters and plans to institute a service for the periodic calibration of the inspectors' instruments.

Sponsor: DOI/MESA

Investigator: J.P. Seiler, Pittsburgh Technical Support Center

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
			5.9	21

Fabrication of a Time-Resolved Audio Dosimeter System

Five time-resolved audio dosimeter systems were developed and tested. This project was completed in July 1977.

Sponsor: DOI/BOM

Investigators: G.R. Sima, Jr., Bendix Corporation, MD.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		34		

Development of a Dosimeter Calibrator

The personal noise dosimeter is currently being used by metal and nonmetal mine inspectors for enforcement of the MESA noise program. To insure the reliability of dosimeter measurements, the Branch is developing an inexpensive, easy to use calibrator system. When completed, the device will permit the quick, accurate calibration of the noise dosimeter using the same GenRad calibrators presently used by inspectors for sound level meter calibration.

Sponsor: DOI/MESA

Investigator: J.P. Seiler, Pittsburgh Technical Support Center

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		2	15.3	6

Development of an Acoustic Coupler for Dosimeter Calibration

The objective of this project was to develop an acoustic coupler for accurately generating high sound pressure levels to allow rapid calibration of audio dosimeters.

Sponsor: DOI/BOM

Investigator: D. Montgomery, Naval Weapons Support Center, IND

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	34.9			

Load and Geometry Factor for Noise Levels Underground

The objective of this study is to determine a numerical factor in mine geometry and for equipment type (under load) which will be used to calculate underground noise levels based on surface noise measurements.

Noise levels from a given type of machinery measured above ground can be significantly different from the noise levels measured underground. Two major factors which are involved in this phenomenon are the geometry of the underground coal mine and the effects of the machine under load condition such as cutting coal. Newly proposed noise standards include underground rating of new mine equipment based on above ground noise measurements. Therefore, it is important to understand this phenomenon and to be able to calculate underground noise levels from surface measurements.

Sponsor: DOI/MESA

Investigator: L.C. Marraccini, Pittsburgh Technical Support Center

Fiscal Year Funding ($1000):	1975	1976	1977
	5	6	6.4

COMMUNITY OR COLLECTIVE RESPONSE

Valuation and Compensability of Noise Pollution

This project was concerned with the development of criteria and measures of determining compensability for excessive noise levels produced by traffic on existing or proposed highways. The research focused on four main goals: (1) Efficiency -- Increasing total net benefits from highway transportation, considering both users and non-users. (2) Equity -- Compensating for noise losses and treating like cases alike. (3) Distribution -- Allocating cost and benefits from highway transportation in accordance with national and social goals. (4) Public Acceptance -- Public satisfaction with effort to reduce and compensate for noise. A model for estimating noise impact was developed. Results from this effort will be used to assess environmental concerns in highway planning, design, cost analysis, and compensation for noise impacts. This project was completed in 1976.

Investigator: E. J. Mosback
Jack Faucett, Inc., Md.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	100			

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Evaluation of Aircraft Single-Event Noise Descriptors

This is an in-house laboratory subjective response study conducted in both a simulated outdoor environment and an indoor environment. The subjects were asked to give annoyance judgments of a variety of aircraft sounds. The annoyance judgments were then compared with acoustic analyses of the noises in terms of the more common physical rating scales.

Investigator: C. A. Powell
Langley Research Center, Noise Effects Branch

Fiscal Year Funding ($1000):

1975	1976	TQ	1977	1978
25	75	20	27.5	75

Effects of Duration on the Human Response to Aircraft Noise

This is a contract study directed toward determining the subjective effects of duration of aircraft noise. A variety of aircraft are used in the study, including general aviation, CTOL, and Concorde. The estimated completion date is 1980.

Investigator: K. Shepard, University of Utah

Fiscal Year Funding ($1000):

1975	1976	1977	1978
15	30	10	

Effect of Blade Slap and Impulsive Noise on Human Response to Helicopter Noise

This study includes both in-house and supported contract work. The in-house effort is pursuing a systematic study to determine the significant factors of subjective response to helicopter noise, such as crest factor, level of continuous noise, blade slap frequency, and blade slap repetition rate. The current contract study is an investigation of annoyance due to rotor noise. The estimated date of completion is 1978.

Investigator: H. Sternfeld, Langley Research Center, Boeing Vertol

Fiscal Year Funding ($1000):

1975	1976	1977	1978
	50	50	50

Trade-Off of Aircraft Noise and Number

This was an in-house subjective response study in which session judgments of aircraft noise annoyance were made over 30-minute sessions. The level and number of stimuli heard during a session were varied and responses were correlated with cumulative exposure indices.

Investigator: C. G. Rice, LRC/Instructor of Sound and Vibration

Fiscal Year Funding ($1000):

1975	1976	1977	1978
50	15		

Perceived Benefits of Future Aircraft Fleet mixes

This is a university laboratory subjective response study with the immediate objective of determining the benefits of retrofitting various classes and types of aircraft in the commercial fleet. Other community and lab studies relating to human response to aircraft noise have been conducted in the JFK airport community. The estimated completion date is 1978.

Investigator: P. Borsky, Columbia University

Fiscal Year Fuding ($1000):

1975	1976	TQ	1977	1978
180	90	10	130	100

Effects of Background Noise on the Human Response to Aircraft Noise

This is an in-house laboratory subjective response study in which subjects rated the annoyance produced by a variety of aircraft noises in the presence of a highway traffic noise background.

Investigator: C. A. Powell, Langley Research Center

Fiscal Year Funding ($1000):

1975	1976	TQ	1977	1978
25	75	20	27.5	75

Effects of Adaptation on Human Response to Aircraft Noise

This is a contract-supported study with a university investigating the impact a person's history of exposure to aircraft noise has on his response to the noise. The study is also attempting to correlate aircraft noise annoyance with annoyance to other every day events. This project is scheduled for completion in 1980.

Investigator: E. Galanter, Columbia University

Fiscal Year Funding ($1000):

1975	1976	TQ	1977	1978
54	25	15	113	100

Field Survey of Passenger Response to Aircraft Noise and Vibration

University contract studies are underway to determine passenger ride comfort in response to aircraft noise and vibration. The studies involve the use of survey questionnaires and have included third-level air carriers and also passenger trains. The studies will be expanded in the near future to obtain data from the Concorde. The estimated date of completion is 1980.

Investigator: I. Jacobsen, University of Virginia

Fiscal Year Funding ($1000):

1975	1976	1977	1978
50	55	100	75

COMMUNICATIONS INTERFERENCE

Effects of Aircraft Cabin Noise on Passenger Response

This area includes both in-house and contract-supported studies. at the present time, the studies are emphasizing speech interference and noise effects on communication ability in an aircraft interior. The studies are being conducted in the acoustics laboratories at Langley. The estimated date of completion is 1980.

Investigator: T. K. Dempsey, LRC, University of Virginia, Bolt Beranek & Newman

Fiscal Year Funding ($1000):

1975	1976	TQ	1977
	35	50	90

NOISE EFFECTS ON SLEEP

Effects of Aircraft Noise on Sleep

This is a basic research study being supported under a university grant. The present studies are directed toward the deveopment of equal arousal curves which would be analogous to equal noisiness or equal annoyance curves. The estimated date of completion for this project is 1980.

Investigator: T. Levere, North Carolina State University

Fiscal Year Funding ($1000):

1975	1976	1977	1978
40	40	40	40

COMMUNITY OR COLLECTIVE RESPONSE

Effects of Fear and Emotions on Human Response to Aircraft Noise

This is a contract-supported study with a university which is directed toward determining the impact a person's emotions or fear of aircraft crashes might have on his response to aircraft noise. The study involves both laboratory research and community surveys. The estimated date of completion is 1978.

Investigator: M. Loeb, University of Louisville

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		60	50	

Day/Night Weighting of Aircraft Noise

Survey research studies will be conducted to determine the response and/or sensitivity to aircraft noise as a function of time-of-day. Of particular interest is qualitative information on the penalty for nighttime operators of aircraft. The estimated completion date for this project is 1979.

Investigator: W. Mayes, Langley Research Center

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			20	100

Effects of Adaptation on Human Response to Aircraft Noise

(See listing under Psychological and Performance Effects)

NOISE CONCOMITANT WITH VIBRATION

Laboratory Simulator Studies of Passenger Response to Aircraft Noise and Vibration

In-house laboratory subjective response studies are being conducted in Langley's Passenger Ride Quality Apparatus which is a five-degree-of-freedom simulator. The simulator can be operated to produce motion in the vertical, lateral, fore and aft, pitch, and roll directions. The simulator also has noise producing capability enabling studies to be conducted in a combined noise and vibration environment. The project is scheduled for completion in 1980.

Investigator: S. A. Clevenson, Langley Research Center

Fiscal Year Funding ($1000):

1975	1976	1977TQ	1977	1978
75	85	50	100	100

Effects of Combined Noise and Building Vibration on Human Reponse to Aircraft Noise

Laboratory studies will be conducted to assess the effects of building vibrations and/or secondary response (rattles) on human response to aircraft noise. The use of loudspeakers and vibration exciters will provide independent control of the noise/vibration stimuli. The estimated completion date is 1979.

Investigator: J. M. Cawthorn, Langley Research Center

Fiscal Year Funding ($1000):

1975	1976	1977	1978
		20	25

Assessment of Concorde Noise-Induced Building Vibration

At the request of the FAA, NASA is conducting studies in the Dulles International Airport area to assess the effects of Concorde operations on building vibration. Both building damage and human effects are being studied. To date, the indoor and outdoor noise and the associated vibratory response of windows, walls and floors have been recorded for several hundred aircraft including Concorde. Estimate date of completion is 1978.

Fiscal Year Funding ($1000):

1975	1976	TQ	1977
		25	35

NOISE INDUCED HEARING LOSS

Effects of Acoustic Trauma on Single Auditory Neurons

Traumatic noise exposures produce a diverse set of changes in normal hearing, presumably because there are modifications in the "neural code" for hearing. The purpose of this research is to systematically determine how acoustic trauma influences the functional properties of single neurons in the VIII nerve and cochlear nucleus. Laboratory animals will be exposed to traumatic noises and the resulting changes in neuronal function will be measured in terms of frequency-threshold curves, tone burst and sweep tone response patterns, two-tone inhibition, and discharge rate versus intensity functions. The traumatic effects of the noise will also be assessed in terms of the degree of hearing loss and the extent of anatomical alterations will be related to the changes in hearing in order to better understand: how the nervous system codes loudness, pitch and other psychoacoustic phenomena, and how the cochlea organizes the afferent "neural code".

Investigator: Dr. Richard Salvi

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
			41	42

Changes with Age in Auditory and Vestibular Epithelia

The purpose of this study is to examine morphological changes in sensory epithelia in "aged" ears.

Investigator: H.W. Ades, University of W. Florida

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		48.5	23.7	

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Effects of Prolonged Noise Exposure: A Longitudinal Study

Laboratory research indicates that short-term exposure to environmental stress can be detrimental to task performance, decrease altruistic behavior, and result in motivational and cognitive deficits linked with the deterioration of health. These effects are often attributed to stress-induced shifts in attentional strategies and locus of personal control. The difficulty with most of this research is that it emphasizes acute rather than long-term effects. This study will suggest some implications of the existing literature on short-term exposure to environmental stress for predicting the impact of prolonged exposure. A well-controlled longitudinal study of the effects of classroom and home noise levels on behavior and health will be done to test the validity of these suggestions. The emphasis of the study is to determine both the immediate and long-term impact of prolonged exposure on children's attentional strategies and generalized expectancies concerning control. Verbal skills and health will be assessed in light of their theoretical relationship to the above mentioned mechanisms. Alternative explanations for the assumed detrimental effects of noise on children will also be examined.

Investigator: S. Cohen, University of Oregon

	1975	1976	1977	1978
Fiscal Year Funding ($1000) :			59.6	

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

Highway Noise Criteria

The goals of this project are to:

- identify and quantify important physical parameters affecting human response to time-varying traffic noise, associated with varying densities of free-flowing highway traffic and stop-and-go urban traffic;
- investigate and compare various measures and computational procedures for rating time-varying traffic noise and determine which method, or methods, best predict the subjective response of people to the noise of various types of traffic situations ;
- develop, if necessary, improved procedures for rating time-varying traffic noise in terms of measurable parameters of traffic noise;
- formulate procedures by which the most useful of the above rating procedures may be related to the environmental noise descriptors and criteria developed by the EPA, if the most useful procedures are found to be different from those recommended by the EPA.

Sponsor: Federal Highway Administration

Investigators: D. Flynn, S. Yaniv
National Bureau of Standards

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		100	100	100

Noise Effects on Boat Operator Performance Collision Research Task Order 27

The objective of this study is an analysis of the relation - ship of noise caused by wind, hull, and engines to the possible degradation of small boat operator performance.

Sponsor: Coast Guard

Investigator: Wyle Labs, Huntsville, Ala.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			50	

Design and Certification Criteria for Sonic Boom Noise

Twelve families were studied in their homes to determine the effects of sonic boom intrusions on their daily living activities. Psychological, sociological and psychophysical measures were obtained. Three ranges of levels were investigated at the rate of 2 per hour from 0700 to 2200 or 30 per day. Actual or simulated boom signals were obtained and described (rise time, overpressure, period) as free-field booms (outdoor booms). They were then attenuated electronically to account for changes due to usual home structure. A minimum of four speakers were used to present the indoor booms and acoustical assessment of the booms was obtained at not less than six different positions in each home. Spectral analyses for all booms at six positions were obtained via Fourier Transforms.

Sponsor: Federal Aviation Administration

Investigator: Mabry, MAN-acoustic and Noise Inc.

Fiscal Year Funding ($1000)	1975	1976	1977	1978
	35	15		

Laboratory Studies of Effects of Various Recorded Flyover Noises on Listeners

This project is an attempt to (a) determine whether the "equal energy" hypothesis is tenable, and (b) determine the effect of helicopter blade slap on annoyance judgments.

Sponsor: Federal Aviation Administration

Investigator: E. Gallanter, Columbia University

Fiscal Year Funding($1000):	1975	1976	TQ	1977	1978
			82.2		80

Evaluation of the Utility of Perceived Noisiness Concepts for Certification of Aircrafts

This project will assess the choice of basic perceived noise descriptors in the aircraft noise certification. Psychoacoustic factors such as those dealing with the contribution of pure tones and multiple pure tones, as well as computational difficulties resulting from signal analysis, will be evaluated.

Sponsor: Federal Aviation Administration

Investigator: to be determined

Fiscal Year Funding($1000):	1975	1976	1977	1978
			250	

Evaluation of Experiments Related to the Study of Aircraft Noise

This project examined the feasibility of using airplane cockpit simulators for experiments on the effects of interior noise on aircrew performance.

Sponsor: Federal Aviation Administration

Investigator: E. Galanter, Columbia University

Fiscal Year Funding ($1000):	1975	1976	1977
			5

COMMUNICATIONS INTERFERENCE

Study of Communication Interference and Performance Decrements in Interior Aircraft Noise Environments

The objective of this study is to investigate the effects of various airplane cockpit noise spectra on different forms of communication and on pilot and aircrew performance.

Sponsor: Federal Aviation Administration

Investigator: to be determined

Fiscal Year Funding ($1000):	1975	1976	1977	1978
			100	

DOT (Continued)

COMMUNITY OR COLLECTIVE RESPONSE

Socioeconomic Factors as Determinants of Noise Acceptance

This study evaluated the annoyance levels in single residence neighborhoods displaying various socioeconomic characteristics where a similar noise environment was found and attempted to correlate annoyance levels with certain socioeconomic characteristics.

Sponsor: Urban Mass Transportation Administration

Investigators: J.D. Martins, U.H. Surti, University of Colorado

Fiscal Year Funding ($1000)	1975	1976	1977	1978
	9			

Opinion Surveys of Concorde Operations at Dulles and J.F.K. Airports

This project will survey the opinions of residents near Dulles and J.F.K. International Airports, regarding the limited operations of the Concorde SST there.

Sponsor: Federal Aviation Agency

Investigators: Dynamic Programming, N.J.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
			41	20

Opinion Survey of Concorde Operations at Dulles Airport

This project surveyed the opinions of residents near Dulles International Airport regarding the decision to admit the Concorde SST to limited operations there.

Sponsor: Federal Aviation Administration

Investigators: Kirschner Associates, Washington, D.C.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
		15		

NOISE CONCOMITANT WITH VIBRATION

Impacts from Vibrations Related to Highway Use

A significant number of complaints and much of the litigation pertaining to environmental vibration stem from highway operations. Such highway vibrations have been cited as causing human psychological discomfort and structural damage. This project will define the nature and extent of the highway vibration problem, by improving the current understanding of vibrations excitations, propagations, and effects.

Sponsor: Federal Highway Administration

Investigators: F. Rudder, Science Applications, Inc.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
	76	101	25	

VETERANS ADMINISTRATION

NOISE-INDUCED HEARING LOSS

Electrophysiological Correlates of Noise and Drug-Induced Threshold Shifts

The purpose of the project is to study the interaction of the antibiotic kanamycin and noise, both of which can cause hearing loss due to cochlear damage. The investigators hope to identify people who are at high risk for cochlear problems. The degree to which people who have suffered this type of noise or drug-induced damage, and then recovered, may be more sensitive later to hearing loss due to age (presbycusis) is also under study.

Investigator: Dr. R.C. Bone, V.A. Hospital, San Diego, Cal.
Dr. Allen Ryan

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	15	30	30	

Relation Between M.C.L. and Threshold for Stapedius Reflex in the Hearing-Impaired

The purpose of this study is to investigate the relationships among Bekesy-tracked most comfortable loudness (MCL) levels for continuous and interrupted pure tones at 500, 1000, and 2000 Hz and the acoustic threshold for stapedius muscle activity for the same stimuli. Subjects will be 75 male patients who sustain greater than 30 dB HTL sensorineural hearing loss (cochlear site of lesion) at the test frequencies. Each subject will receive a complete audiologic diagnostic evaluation (pure tone thresholds, speech reception thresholds, speech discrimination tests, tone decay test, SISI, Bekesy, and admittance tests) to verify site of lesion. Reflex thresholds will be ascertained, and subjects will track MCL levels on a Grason-Stadler 1701 Automatic Audiometer. The calculation of regression equations for a loudness-based physiologic phenomenon (reflex threshold) upon a loudness-based perceptual phenomenon (MCL) will assist in the diagnosis and rehabilitation of incapacitated and/or uncooperative patients as well as adding to auditory theory regarding the relationships among loudness-based auditory phenomena.

Investigators: R.W. Matthes, V.A. Hosptial, Brooklyn, N.Y.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		24	24	

Changes in Auditory Function Accompanying Noise-Induced Hearing Loss

Two groups of 16 young male subjects with normal low and mid-frequency hearing were compared on a series of audiometric measures. One group was composed of subjects with significant histories of noise exposure and hearing losses at 4000 Hz greater than 40 dB HL (ISO, 1964); the other group was composed of normal hearing subjects with no history of unusual noise exposure. On fixed-frequency Bekesy audiometry at 2000 Hz, 12 of the noise exposed subjects demonstrated significant separation between pulsed and continuous tone tracings; similar separation occured for only one of the non-noise exposed subjects. Significant inter-group differences also occured on these tests of speech discrimination: PB-50 word lists, and CID W-22 lists presented with two forms of competing noise.

Investigators: Dr. M.D. Patterson, R.C. Findlay, University of Pittsburgh

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	6.5			

NON-AUDITORY HEALTH EFFECTS

Analysis of Cognitive Functioning in Psychopathology

The project consists of four parts, of which one involves noise. The purpose of this study is to test methods of classifying subjects into various coronary-prone behavior patterns. The effects of both failure at a problem and a noise stress of 90 dB white noise on subjects with either type A behavior (coronary-prone) or type B behavior (non-coronary-prone) are being studied. Blood levels of lipids and other coronary risk factors are being recorded. The data collection is 75% completed.

Investigator: Dr. V. Pishkin, V.A. Hospital, Oklahoma City, OK.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		1.5	1.5	

The Effects of Noise on Behavior

That noise in our urbanized society has deleterious effects on humans is well-known, especially the effects of high noise levels. But less well-understood are the effects of various parameters of moderate noise, the topic of this project. The subjects were young white rats, exposed to continuous moderate white noise.

Preliminary findings revealed a difference in growth rate between males and females (as compared with known growth rates of this strain of rats) apparently based on the effects of the noise on life processes. Offspring of these rats to several generations showed increasing sex differences in growth.

Investigator: B.D. Kaiman, V.A. Hospital, Johnson City, Tenn.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	5	5		

PSYCHOLOGICAL AND PERFORMANCE EFFECTS

An Investigation of Learned Helplessness and Depression

The experiment tested two theories of depression--Lewinsohn's theory and Seligman's concept of Learned Helplessness on a clinical sample. Learned helplessness has been advanced as a model for depression in humans. Ninety-six male subjects from the V.A. Hospital and Northport (psychiatric in- and outpatients, medical patients, and staff) were required. The present experiment is a 3 (Nondepressed, Low depressed, High depressed) X 4 (different experimental pretreatments: Escapable-noise, active contingency; Escapable-noise, passive contingency; Inescapable noise; and No Noise) mixed factorial design. The dependent measure will be performance on an anagrams task, subsequent to the experimental pretreatment. Learned Helplessness theory predicts that there will be performance deficits on the anagrams task for depressed subjects (relative to nondepressed subjects), and inescapable-noise subjects (relative to escapable-noise subjects); and that Seligman's prediction of no difference between the performance of active- and passive-escape subjects will be borne out, rather than Lewinsohn's prediction of a significant difference generated by active- and passive-escape contingencies.

Investigators: C.S. Raps, L. Cohen, Va. Hospital, Northport, N.Y.

Fiscal Year Funding ($1000) :	1975	1976	1977	1978
		7.5		

The Relationship Between the Acoustic Reflex and Loudness Discomfort

Two measures of loudness discomfort were studied in two groups of subjects--one group was instructed to signal the point of physiological discomfort; the other group the point of annoyance. The study was done with both white noise and speech. The instruction to indicate where the sound is annoying or uncomfortable is far more reliable than the instruction to respond when the sound produces physiological discomfort.

Discomfort levels for speech were substantially lower in intensity than for white noise in both groups. Although these stimuli are close in spectral content, there is an apparent psychological difference between the concept of loudness discomfort for white noise and speech. Subjects will seemingly tolerate much more intensity for speech than for white noise.

Investigators: B.Z. Rappaport, B. Milburn, V.A. Hospital, Ann Arbor, Mich.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
		4.5		

COMMUNICATIONS INTERFERENCE

Psychoacoustic and Speech Processing Manifestations of Aging

A major part of this project concerns how well elderly people perceive speech under difficult listening conditons, such as with distracting noise. The study is particularly concerned with reverberation type noise. Speech recognition scores under these conditions are being compared for groups of elderly people and younger subjects. The effect of aging on dichotic listening (two different sounds into each ear) is also being studied.

Investigator: Dr. S.A. Gelfand, V.A. Hospital, East Orange, N.J.

Fiscal Year Funding ($1000):	1975	1976	1977	1978	1979
		110	110	110	110

The Effects of Various Interfering Noises on the Speech Discrimination of Normal and Pathological Hearing Groups

The purpose of this study is to describe and compare the effects of several types of interfering noises on the ability of subjects with normal hearing and sensorineural hearing loss to discriminate monosyllabic words, to investigate, for patients with a sensorineural hearing loss, the relationship between pure tone configuration and speech discrimination scores in various noise backgrounds, and to compare speech discrimination scores to self-assessment scores of hearing handicapped subjects with sensorineural hearing loss.

One group will consist of 15 normal subjects and the second group will consist of 45 males with sensorineural hearing loss. These groups will be chosen on a basis of pure tone configuration with respect to onset frequency of loss and degree of loss at subsequent octave frequencies. All patients will receive the following audiological battery: 1. Complete Audiometric Examination consisting of pure tone air and bone, Spondee Threshold test, and Speech Discrimination Test. In addition, each patient with a sensorineural hearing loss will be given a scale for self-assessment of hearing handicap and will be tested for his speech discriminatiion ability in quiet, and under 3 different types of noise.

Investigator: R.H. Baker, V.A. Hospital, Brooklyn, N.Y.

Fiscal Year Funding ($1000):	1975	1976	1977	1978
	25	25	25	25

APPENDIX C

RESEARCH FUNDED BY STATE, MUNICIPAL AND PRIVATE INSTITUTIONS

NOISE-INDUCED HEARING LOSS

Inter-Industry Noise Study: Steady-State Noise (Phase I); Intermittent Noise (Phase II)

The inter-industry noise study is financed by a number of industries and trade associations. Phase I of the study, which was recently completed dealt with the effects of steady state noise between 82 and 92 dBA on the hearing loss of industrial workers. The study was done over a three year period and involved 610 male and female workers. The study was carefully designed and controlled to avoid the pitfalls of earlier studies, and to produce scientifically valid data.

The investigators' conclusions are that the data shows no meaningful hearing loss at the speech frequencies of 500, 1,000 and 2,000 hertz. The effect of noise on frequencies 3,000 and above is still in question.

Phase II of the study which commenced in 1977 deals with the effects of intermittent noise.

Sponsor: Supported by a number of trade associations and industries

Investigator: Joseph Sataloff
1721 Pine Street
Philadelphia, Pa.

Period: Phase I - 1974-77
Phase II - 1977-79

Funding: $200,000 (Phase I)

A Scanning Electron Microscopic Study of Cochleas with Noise-Induced Losses in Sensitivity

The investigator will examine the cilia of hair cells of cats' cochleas which have shown permanent losses in sensitivity of single nerve fiber units after exposure to narrow-band noise. A detailed correlation of the anatomical and physiological changes will be made to elucidate the normal mechanisms of detecting and coding the impingement of sound.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Michael J. Mulroy
University of Massachusetts

Period: 1977 (start date)

Funding: $10,000

A Neurobehavioral Analysis of TTS and Related Phenomena: Response of Single Cochlear Nucleus Cells in the Behaving Monkey

A physiological and behavioral study of changes in neural function that underlie acoustic overstimulation, the work will involve the monitoring of responses in the anteventral cochlear nucleus of unasesthetized monkeys performing auditory tasks, and then the sorting of the quantitative data.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Bryan E. Pfingst
University of Washington

Period: 1977 (start date)

Funding: $10,000

Selected Ultrastructural Aspects of Inner Ear Development in the Guninea Pig

The researcher intends to acquire information on the development of hair cells in the vestibular portion of the guinea pig cochlea, their innervation, and the presence of glycogen in the stria vascularis.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Peter Heywood
Brown University

Period: 1977 (start date)

Funding: $10,000

Functional Differences Between Inner and Outer Hair Cells

Through parallel experiments with three groups of guinea pigs-- (1) with exposed inner ears and kept in silence, (2) with intact ear structures but exposed to a series of sound-silence stimuli through cochlear microphonic infusion, and (3) those exposed to pure-tone stimulation -- the researcher wishes to determine the stimuli organization of synaptic activity in the hair cells and to find the minimal intensity level needed to cause a detectable horseradish perioxidase uptake in the inner hair cells.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: William E. Brownell
University of Florida

Period: 1977 (start date)

Funding: $10,000

Studies of the Cochlear After-Potential

Using electrophysiological techniques, the researcher will try to determine the properties of the cochlear after-potential and to explore the degree to which these responses can be masked, fatigued, and influenced by adverse physiological states.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: John D. Durrant
Temple University School of Medicine

Period: 1977 (start date)

Funding: $10,000

Acoustic Stimulation and Brain Development

Groups of embryonic chickens were presented with varying amounts of calibrated acoustic stimulation during critical periods of development and several morphological and physiological characteristics of auditory neurons in the brain stem nuclei magnocellularis and laminaris were compared in these and appropriate control animals. The experiment was designed to allow virtually complete control over the intensity, frequency and duration of acoustic stimulation presented at any stage in development and to allow precise quantitative measurement of resulting change in the neurons under study.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Dr. E. W. Rubei, T. N. Parks
Yale University

Period: 1976

Funding: $10,000

Receptor Potentials and Neural Response in Acoustico-Lateralis Sensory Cells

A model has been developed that can be used to study hair cell transduction. The researcher is measuring the responses of the model to an applied stimulus, to validate its usefulness in determining the effect of drugs and of intense stimuli on transduction.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: John Robert Boston
Carnegie Mellon University
U. of Pittsburgh Medical School

Period: 1977 (start date)

Funding: $10,000

Study of Potentiating Harmful Effects of Low-Level Noise and Kanamycin on Guinea Pig Cochlea

This research will try to determine the lowest level of noise in combination with kanamycin that produces hair cell damage, when this occurs, and whether young and old animals are equally vulnerable. Early data shows that damage occurs as an effect of noise and otoxicity in the first five hours after administration of the drug (when its levels are highest) and that the minimal level of damaging noise in this kind of experiment is above 80 db of white noise.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Vijay Shanker Dayal
University of Toronto

Period: 1977 (start date)

Funding: $10,000

Multiple Fiber Sampling from the Auditory Nerves of Chinchillas Exposed to Intense Sound: A "Neural Cochleogram"

The investigator has built and tested an auditory physiology laboratory, and has begun his experiments recording the neural responses of 100-200 individual fibers to one or more stimuli in each subject, then of studying microscopically each inner ear to locate and measure sound-induced lesions.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Mario A. Ruggero
University of Minnesota

Period: 1977 (start date)

Funding: $10,000

The Physiological Mechanisms Related to Primimg for Audiogenic Seizures in Rodents

Hamsters and mice were "primed" for audiogenic seizures by exposing them briefly to noise at selected ages. Priming when 28 days old in the hamsters produced a significant evoked response threshold loss when tested at 42 days. Re-exposure to the priming stimulus at 42 days also produced seizure behavior. The susceptibility to seizure behavior was studied in hamster as a function of age. Groups of C57BL/6J mice were primed with a brief noise exposure when 14, 18, 28, 38, or 58 days old. Five days later some of these animals were behaviorally tested for seizures while the cochlear microphonic responses of others were measured. Preliminary data showed that priming on day 18 produced the most severe seizure behavior and greatest derangement of cochelar function. Priming on day 14 or 58 had little effect.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Dr. J. C. Saunders
University of Pennsylvania
School of Medicine

Period: 1975

Funding: $10,000

Terminal Innervation of Inner Ear Structures

The first year (1974) of the two year project was devoted to a light and electron microscopic study of the terminal innervation of the guinea pig cochlea.

During the second year (1975), the response of the peripheral innervation of the inner ear to varying degrees of acoustic trauma was examined. An effort was made to determine whether there is differential susceptibility of the various types of nerve fibers (i.e. afferent, efferent, and autonomic) to high intensity noise to learn which portions of the innervation are most likely to survive in a noise-damaged ear. The investigator also studied the process of retrograde degeneration toward the CNS and the possibility of regeneration of peripheral auditory nerve fibers following damage due to noise exposure.

Guinea pigs and chinchillas served as experimental animal models and the work was done using a combination of light and electron microscopic methods.

NIHL (Continued)

Sponsor: Deafness Research Foundation, N.Y.

Investigator: C. G. Wright
University of Michigan
School of Medicine
Ann Arbor, Mich.

Period: 1974-1975

Funding: $10,000

Effects of Noise on the VIII Nerve and Cochlear Nucleus

The goal of this project was to determine how the normal discharge patterns of single auditory neurons in the VIII nerve and cochlear nucleus change during a temporary and permanent hearing loss. The objective was to learn whether the neurophysiological alterations that occur during a temporary hearing loss are the same as those for a permanent hearing loss, and to relate the modifications in the discharge patterns to several audiological disorders for which there are neurophysiological models.

Sponsor: Deafness Research Foundation, N.Y.

Investigator: Dr. G. F. Reed, D. Henderson
State University of New York
School of Medicine
Syracuse N.Y.

Period: 1975

Funding: $10,000

The Effectiveness of Ear Protectors in Preventive Temporary Threshold Shifts

Several different types of insert ear protectors will be evaluated in different industrial environments with regard to their capability to prevent temporary threshold shifts.

Sponsor: E. A. R. Corporation

Investigator: L. H. Royster
Department of Mechanical and Aerospace Engineering
North Carolina State University
Raleigh, N.C.

Period: June 1977 to September 1978

Funding: $4,000

Collaborative Research Program in Neonatal Development

Establishment of a collaborative program of research in neonatal development between the Perinatal Clinical Research Center of the Department of Reproductive Biology, School of Medicine and the Perceptual Development Laboratory of the Department of Psychology. Studies will include the effect of noise on the development of hearing in premature infants.

Sponsor: Grant Foundation Incorporated

Investigator: Dr. I. B. Weiner, V. A. Binzley
Case Western Reserve University

Period: 1975

Funding: $28,000

Study of Tinnitus

This study will examine four or five different ways of masking tinnitus to be used as relief procedures for this malady.

Sponsor: Murdock Charitable Trust
Medical Research Foundation of Oregon

Investigator: Dr. Jack Vernon
Kresge Hearing Research Laboratory
University of Oregon
School of Medicine

Period: September 1977 to September 1980

Funding: $180,000

Audiometric & Physiologic Correlates of Noise Susceptibility

This project represents a continuing interdisciplinary effort to develop clinically useful audiometric and physiologic screening tests for detecting noise susceptibility in human subjects. The project is designed to investigate correlations between audiometric and hormone-metabolic response patterns to noise stress which will ultimately elucidate the mechanisms whereby some individuals are more prone to develop noise-induced hearing loss than others. One practical use of such tests would be to screen employees working in noisy environments to allow management to take appropriate protective action to prevent both noise-induced hearing impairment and stress responses.

Sponsor: Rockefeller Foundation

Investigator: A. Anthony, P. L. Michael
Penn State University
Physiology Group
Environmental Acoustics Laboratory

Period: 1978 (completion date)

Funding: $75,000 (over 3 year period)

The Effects of Exposure to High Noise Levels On Employees In Several Types of Industrial Environments

This study dealt with the effects of noise, 85-90 dBA, on employees in industrial environments and the effectiveness of existing hearing conservation programs.

The results, similar to those of Baughn, Robinson, NIOSH, and Passchier-Vermeer indicated that 10 to 12 years of exposure to a daily L_{eq} of 89 dBA, causes measurable hearing loss at 4 kHz.

Sponsor: Rockefeller Foundation

Investigator: L. H. Royster
Dept. of Mechanical & Aerospace Engineering
North Carolina State University

Period: March 1975 to December 1977

Funding: $41,000

Effects of Psychosocial Stress and Noise on Renin

The aim of this study was to determine whether psychosocial stress of noise acutely and chronically produces changes in renin secretion, salt metabolism, and blood pressure in unanesthetized mice and rats. Acute animals were exposed to thirty-minute periods of "open-field" stress, fear-induced stress (exposure to trained fighters), or noise, after which they were exsanguinated by decapitation; renin activity, concentration, and substrate were measured. Chronic animals were subjected to crowding, territorial-conflict situations, or intermittent noise; they were monitored for blood pressure, salt balance, plasma electrolytes, and renin parameters.

Sponsor: American Heart Association, Inc., Michigan Heart Association

Investigator: Dr. A. J. Vander
University of Michigan
School of Medicine
Ann Arbor, Michigan

Period: 1976

Funding: $12,000

Cytophotometric Analysis of Neurochemical and Adrenocortical Changes in Noise Stressed Rats

The main objective of this project was to describe the nature and extent of histophysiological alterations in selected areas of the brain in noise-exposed animals using combined techniques of histochemistry and absorption microspectrophotometry. A supplemental aim was to initiate investigations focused on describing relationships between events in brain and associated pathways with histochemical changes in the adrenal cortex. It was anticipated the overall data would provide valuable insight into the nature of inhibitory-protective neural mechanisms of the nervous system.

Sponsor: Rockefeller Foundation

Investigators: A. Anthony, R. Farwell
Penn State University

Period: 1975

Funding: Unknown

Evaluation of the Acoustical Environment of Classrooms

The Environmental Acoustics Laboratory and the Architectural Engineering Department conducted an interdisciplinary study that was directed toward the development of an effective method for evaluating the various aspects of human perceptual response to noise in the environment and, in particular, in the classroom.

Sponsor: Rockefeller Foundation

Investigators: P. I. Michael, H. F. Kingsbury, G. R. Bienvenue
Penn State University

Period: 1975

Funding: Unknown

Effects of Freeway Noise on Hearing Level and Academic Achievement of Children

In this study, State achievement test scores of children in elementary schools near freeways will be examined and compared to those of children with similar socio-economic backgrounds in schools not exposed to freeway noise. Noise measurements will be taken in the schools, hearing tests will be conducted and community noise levels will be determined.

Sponsor: California State Government (financial assistance also from DOT/Federal Highway Administration)

Investigator: Dr. Jerome Lukas
California Department of Health

Period: July 1977 to January 1979

Funding: $280,000

Effect of Noise on Educationnaly Related Tasks in a Public School

Purpose: To study the effects of elevated noise levels upon performance of tasks of auditory discrimination, visual-motor performance, and visual discrimination.

Subjects: 85 children enrolled in fifth and sixth grade levels in regular academic classrooms served as subjects.

Methods: Each classroom was evaluated for a period of two weeks--one week under normal ambient noise levels and one week under ambient plus 15 dB. Order of noise conditions was rotated. At the close of each school day the children were given three tests: auditory discrimination (comparison of pairs), visual-motor (putting dots in circles of various sizes), and visual discrimination (visual search task to match pairs) tasks.

Findings: Early assessment of data indicates noise has an adverse effect on auditory discrimination and visual discrimination. Results are are not yet consistent with regard to visual motor performance.

Sponsor: Wichita City Government, Kansas

Investigator: Prof. R. L. McCroskey, J. S. Devens
Wichita State University

Period: 1976

Funding: Unknown

The Effects of Electrical Noise Sources on People

Noise from transformers and power lines is the principal concern. The effects of noise will be studied through laboratory experiments, behavioral response-awakening in the home, and an attitudinal community survey.

Sponsor: Electrical Power Research Institute, Palo Alto,

Investigator: K. S. Pearsons
Bolt, Beranek and Newman
Canoga Park, Calif.

Period: February 1977 to Fall of 1978

Funding: $280,000

Noise Effects of the Concorde on the Community Surrounding JFK International Airport

Sponsor: New York Port Authority

Investigator: Dr. James R. Young
Stanford Research Institute
Menlo Park, Calif. 94025

Period: 1977

Funding: Unknown